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THE EFFECTIVENESS OF THE BUREAU SYSTEM IN NAVAL ORGANIZATION.

This article was prepared, at the request of the editors of THE ENGINEERING MAGAZINE, by an authority amply qualified through intimate familiarity with Naval affairs. His facts are drawn from his own knowledge and from official data. It is, of course, evident where he belongs, and evident also that he cannot afford to incur the dislike of the powerful line of the Navy by disclosing his identity. We shall say only that he is a man of the highest standing and integrity, with a reputation for absolute fairness; and that his name, if published, would be ample guarantee of the accuracy of his statements and the soundness of his judgment. It is very interesting to place his conclusions in parallel with those expressed by Mr. Emerson in a following article in this issue, and to see how true it holds that in naval and military affairs, as in civil pursuits, pure line organization or administration resists progress and results in low efficiency, and that effectiveness and advance can be secured only by constantly vitalizing the line through the ideals and standards originating with the staff.—THE EDITORS.

FROM time to time articles have appeared in the daily papers, and occasionally in some of the magazines, criticising the present organization of the United States Navy Department and asserting that its efficiency would be vastly increased if a different plan were adopted. While the various critics are not agreed as to the best plan, the great majority of them advocate a system which would in effect make the Secretary of the Navy a figure head, and would practically turn over the entire naval administration to that branch of the Navy called the "Line." It may be explained for the benefit of readers not familiar with naval terminology that the line officers are the ones whose duties, when at sea, are principally on deck, namely, admirals, captains, watch officers, etc. Of late, they quite often call themselves the "sea-going officers," and they constitute the vast majority of the commissioned officers at sea.

When a serious change is proposed in any organization, it naturally ought to be on the ground that the new method would be more efficient or more economical, and it would ordinarily be expected that examples would be given of the inefficiency of the organization which it was proposed to supersede. In most of the articles which are written to advocate a change, there is never any attempt to go into details, but there is a lot of special pleading to show that the line of the Navy ought to be given control, and no attempt to point out the defects of the present Bureau system. This is not always the case, however, and last year the newspapers were full of the accounts of the Congressional investigation into the condition of the ships of the United States Navy, which resulted from charges of gross mistakes of design made by a gentleman whose work in connection with Navy matters has been that of a newspaper artist. It was charged that American ships were decidedly inferior to those of other large navies in almost every respect; and, indeed, if this artist had been believed, the people of the country could only have thought that millions of dollars had been spent in producing a very defective lot of ships.

Those who followed this investigation carefully, and especially those who took the trouble to get the published official report of the hearings, will remember how completely this artist's story was demolished by the extremely able testimony and record of facts produced by Admiral Capps, Chief of the Bureau of Construction. He showed conclusively not only that the criticisms were unfounded and false, but that, as a matter of fact, in almost every point which had been brought up by the critic American ships were superior to those of other navies. In doing this Admiral Capps was defending the work of his bureau, although not his own, as the ships which were criticised had been designed and built under the administration of his predecessors.

One feature which was brought out very strongly during this investigation to those who have been familiar with naval matters for the last twenty or thirty years, was the evident existence of a concerted effort on the part of certain ambitious line officers to discredit the Bureau system, with a view to bringing about the change which this element in the Navy has so often urged—namely, the organization of the Navy Department into two or three divisions, each under the control of a vice-admiral. One of the recent newspaper articles, when boiled down, amounts to this; that as the line officers are the men who handle the ships, including their guns and machinery (for it must not be forgotten that there are no longer any engineers by that name in

the Navy, marine engineering having become one of the essential qualifications of line officers by the Personnel Law of 1899) they ought also to be the ones to say just how the ships shall be built; and, in short, they are the Navy, or in the slang of the day "the whole thing." To any one who stops to reflect on the ordinary conditions of daily life this claim must seem flimsy and without any foundation. According to this, only pianists should make pianos, only organists should build organs, only chauffeurs should build automobiles, Hank Haff and Charlie Barr would be the best yacht builders. This pretence at an argument is really so flimsy that it is useless to waste time on it.

A development of the same idea, however, is worthy of attention—namely, that the officers who handle the ships should have a voice in their design. The appropriate answer to this is that there has never been a time in the Navy (and probably never will be) when the sea-going officers did not have a very strong voice in the design of the ships. At the present time (and for many years) there is a board of officers in the Navy Department known as the Board of Construction, which consists of the heads of the bureaus which have to do with the design and building of the ships. For quite a period recently, in addition, there was as president of this board an admiral who had been a chief of bureau but who had retired. The point is that a majority of the members of this board are line officers. Indeed, since the engineer in chief became a line officer, all the members, except the chief constructor, are members of the sea-going branch. This board has the final say, under the Secretary, respecting all matters of the design and construction of vessels, which certainly seems to provide adequately for giving sea-going officers an opportunity to have their views considered and the benefit of their actual handling of ships at sea put to good account.

It by no means follows, because it is desirable that sea-going officers should have a chance to present their opinions, that the Department should be so organized that their opinions are necessarily final —or rather, that other officers (and especially the technical ones) should be put in the position of not having access to the Secretary, except through superiors who are sea-going officers. This is a point which is perhaps not thoroughly appreciated by non-military people. The military organization, while not going quite so far as the Church of Rome in believing that its head cannot be wrong, does theoretically assume that the higher an officer's rank, the more nearly apt he is to be right. As the Department is now organized all chiefs of bureaus are

peers and all of them have the same right of access to the Secretary. The proposed organization, mentioned a short time ago, of several grand divisions, each presided over by a vice-admiral, would relegate the technical officers to a secondary position where they could not have access to the Secretary without going over the heads of their immediate superiors. This is such a serious matter militarily that no junior ever resorts to it except in desperation.

Among staff officers of the Navy it is the general belief that the scheme of grand divisions controlled by sea-going officers has for its distinct aim to prevent them from having access to the Secretary. It is sad to have to say so, but the experience of the Navy has shown that the possession of practically absolute authority has about the same effect in the Navy as it has everywhere else—namely, a decided tendency to cause narrowness of view with tenacity of opinion in a very high degree. In other words, if the Department were reorganized in this way the technical experts would practically be forced to do what their military superiors insisted upon, whether it was best or not.

That the views of sea-going officers are unfortunately often in the nature of fads or whims has been shown in a number of cases; but Admiral Capps' testimony called very marked attention to this in the case of the "superposed" turrets—generally regarded as defects in a number of our battle ships—whose adoption was strongly opposed by the Bureau of Construction. At least two special boards, composed almost entirely of line officers, discussed this question; and it was on their recommendation that the superposed turrets were adopted, although opposed to the last by the constructors.

Another scheme which has been proposed as a modification of the existing organization is the addition of a naval general staff, which has thus far been escaped owing to the opposition of Senator Hale, chairman of the Senate naval committee. One part of the work which a general staff would perform is undoubtedly very necessary and would be highly beneficial—namely, that relating to personnel and to the planning of naval campaigns. It is a little hard for the ordinary observer, however, to understand why this could not be done just as well under the auspices of the Bureau of Navigation, which at present is charged with the administration of personnel matters and could easily arrange for enough assistants to the chief of bureau with proper rank and experience to do this important work. Staff officers, however, are inclined to feel that if a general staff were introduced, it would have for them about the same effect as the organization by grand divisions, and they cannot see that the Department or the

country would receive any benefit, while they believe the Department and they themselves would be injured. Standard reference books say that, in the army, the chief of staff has supervision of all bureaus, thus requiring all matters to go to the Secretary through him.

An argument which is sometimes advanced for turning over the control of the Navy Department to the sea-going officers is, that as the Secretary is a civilian and without intimate knowledge of naval details, he cannot intelligently decide the questions which come before him, so that he should be relieved of such a responsibility by having naval aides (such as the vice-admirals already mentioned or a chief of the general staff) who will decide them for him and make his official life a sweet dream, whose chief duty would be to pose on occasions of ceremony. This argument is probably perfectly natural to naval men who have been in command a long time. Each commanding officer in his own ship is a little king, whose word is law and who does not have to justify his intellectual processes to those with him, for all are his subordinates. He can not see how a lawyer or a business man can possibly tell him anything about his own profession. While many naval line officers are men of broad culture, it does seem that, as their work is mainly executive on a small scale, they pay no attention to the executive work on a vastly larger scale which is performed with such high efficiency in the railroads and other large organizations on shore. If they understood about this, they would know that it is the exception, rather than the rule, where the head of these great concerns is a technical expert in the line of work over whose administration he exercises supervision. For example, Carnegie, Frick and Judge Gary —none of them is a technical steel man. The presidents of most of our large shipbuilding concerns are not shipbuilders by training. The presidents of most of the large electrical companies are not electrical engineers. A number of the most successful railroad presidents are lawyers by training. The fact is that executive ability is largely a natural gift; at all events, it is entirely separate from technical skill. The able executive does not have to decide minute points of technical detail, but handles the great questions of policy, and he knows how to extract from subordinates enough of the technique to make his decisions sound. It is conceivable, as an intellectual diversion, that a conspiracy to deceive a civilian Secretary might be so general as to lead him astray; but this would be to assume that our naval officers, to advance their personal ends, would lose all sense of honor. Even their worst enemy would hardly charge them with this, although an analysis of what some of them charge against others, in their desire to

grasp exclusive control, comes very near it. The term "politician" has come to have so many unpleasant associations that one is apt to forget that even a politician cannot attain sufficient prominence to secure a cabinet office unless he is a man of decided ability, and that ability, from its very field of operation, is executive—the handling of men. It all comes to this: that the questions which come to the Secretary for decision are either of simple justice, in which case a man free from all naval prejudices is decidedly the best man; or, if of a technical nature, they are on broad lines which he decides just as the head of any other large organization would do, by careful weighing of advantages and disadvantages. And here again the freedom from naval prejudice should, at least, not be a disadvantage.

It is apparently forgotten by the critics of the bureau system that it did not start full-fledged with the organization of the Navy Department, but on the contrary has been a gradual evolution corresponding quite accurately to Herbert Spencer's definition of evolution, which substantially says that it is a change from unorganized sameness to a definitely organized variety with specialization of functions. For a long time the Navy Department was managed by what was known as the "Board of Navy Commissioners," and the sea-going officers were supreme; so that the evolution has been away from the very plan that the critics are now recommending. Long after the first organization into a few bureaus, when steam came into the Navy, engineering was only a subdivision of another bureau, and it was not until the stress of the Civil War made it absolutely necessary that the Bureau of Steam Engineering was formed as a separate one. At this same time the former Bureau of Construction, Equipment and Repair was divided into the three new bureaus, of Equipment, Construction and Repair, and Steam Engineering.

This specialization of function has naturally tended to the development of experts along particular lines, and the line of the Navy, with its multifarious duties, has developed these specialists in ordnance, electricity, torpedoes, gunnery, etc. Unless the history of the Navy were to be absolutely contrary to all other experience, it would be expected that where each bureau is charged with a special duty and its chief has full responsibility for the work coming within his cognizance, there would be a decided increase of efficiency and an incentive to keep his work in the very forefront of progress. Those who believe that the Bureau system is right maintain that this has been the fact, and certainly engineers who look back over the administration of that grand old man, Melville, while he was Engineer in Chief of the

Navy, cannot doubt that he illustrated this point most thoroughly. The mention of Melville's case is quite appropriate as pointing out what might happen if the suggested changes were made. Those who remember the details of their design will recall that Melville, against much opposition and well-meant advice not to do it, decided to use three screws in the wonderful flyers, Columbia and Minneapolis, which at the date of their trials (1893 and 1894) and for a number of years after were the fastest large vessels in the world. The construction bureau provided splendidly designed hulls and was entitled to more credit than it received, but the papers generally called them Melville's ships and gave him nearly all the credit. Whether it was due to jealousy of his success cannot, of course, be said, but it is nevertheless a fact that from the date they were put into service they were never popular with the line officers. The late Admiral Meade is on record in the proceedings of the Society of Naval Architects abusing them roundly. Some unkind people have said that as there are three screws to operate, it made more trouble for the deck officers and that this was the cause of their unpopularity. This, of course, is absurd, as the professional skill of our line officers is rarely called in question.

This is not an isolated case. Isherwood, more than twenty years before, had made the Wampanoag even more of a success for her day than the Columbia and Minneapolis were in theirs. She was the fastest steam vessel afloat by more than three knots. It has been asserted that the possession of the Wampanoag and her class by the United States was an important factor in the settlement of the Alabama claims at Geneva. Did the sea-going officers take pride in this wonderful ship? They did not. They still thought that sails were supreme. They hated engineers and machinery. The Wampanoag was never put into regular service but promptly laid up in "ordinary." A board of sea-going officers pronounced her a failure because of lack of sail power! They recommended removing part of her boilers and rearranging the masts so as to make her a full rigged sailing vessel! This board even had the delicious (but unconscious) humor to say that the utter failure (in their opinion) of the Wampanoag as a war vessel was a signal illustration of the danger of "ignoring experienced and intelligent naval minds as to the properties to be secured in the construction and arrangements of a vessel of war." (These statements are not made from memory but are found in the reports of the Secretary of the Navy.).

When such cases as these are only sample illustrations of the intense prejudice of the sea-going officers and of the way in which they allow their prejudices to blind them to the best interests of the Government, can any one believe that the public welfare would be increased by giving them absolute control of the Navy Department and making the Secretary a mere ornament?

As further illustrating this point of giving sea-going officers complete control, it is a matter of history and official record that during Grant's first term, his Secretary of the Navy, Borie, for a time turned the actual administration over to Admiral Porter. Admiral Porter was a sailor in the strict etymological sense of the term, in that he believed there was nothing like sails. As soon as he was in authority he caused the four-bladed propellers of the vessels to be removed and replaced by two-bladed ones in order that the ships might manœuver better under sail. The inefficiency thereby brought about is, of course, apparent to any engineer, as the size of the propeller opening was fixed and the two-bladed screw could not be made large enough. A few years later, in a report to the Department, he actually claimed that the vessels were faster under steam with the mutilated screws. The facts, of course, were just the reverse, and when his influence became less, proper propellers were again fitted. This was when he was still in his prime and his judgment was, at least, not impaired by age. About twenty years later, when the Roach cruisers were being built, the dear old man, then over seventy, went before the Naval Committee and said that the plans of these vessels were wrong because they had only auxiliary sail power. In his judgment they should have been given full sail power with steam as an auxiliary. He was still a sailor! The world had not moved for him.

Repeated attempts have been made to injure the Bureau system, sometimes directly and sometimes indirectly, but in almost every case the result was a decided misfortune to the Department and the Government. With the beginning of the new Navy and the building of what were known as the "Roach cruisers," a special board, known as the "Advisory Board" was organized, two of whose members were civilians. The result of their work was so unsatisfactory that broad-minded line officers came out frankly and said that it was an entire mistake to attempt to build ships under such a plan.

When Secretary Whitney took office, certain line officers secured his ear and persuaded him to buy plans abroad, instead of having them prepared by the bureaus. A long and interesting story could be told about this, and of how the non-technical line officers who bought the

plans were gold-bricked. The fact is, however, that two out of the three ships which were thus built were always unsatisfactory and were known to be so throughout the service.

Just how far the distribution of work among divisions or bureaus of equal rank should be carried in any organization is difficult to say; but there can be no doubt that, in general, when there is enough specialized work to require a large force under competent executive direction, the time has come for giving the head of this office real standing and real responsibility. This principle is carried out in all large undertakings in civil life, such as the great railroads, the manufacturing plants, etc., and it has been found the best system for securing economy and efficiency. It has been carried out in the other departments of the Government as well as in the Navy Department, and it is true abroad, as well as at home. It can hardly be possible that the general practice of the world is wrong, and that it has been reserved for a few ambitious line officers of the United States Navy (to whom this proposed reorganization is only an incident to more rapid promotion) to be right.

The statement can be made with confidence that the Bureau system of the Navy Department has proved its efficiency. Responding to the environment and the survival of the fittest, the system carried the Navy through the Civil War most successfully. When the war with Spain came, it again proved entirely adequate and highly efficient. If any weaknesses developed, such as the circumstances that led to the Sampson-Schley controversy, and lack of developed campaign plans, they were distinctly due to the line officers themselves and not to the Bureau system. The War College, the Naval Intelligence Office, the General Board—everything they have asked for along the lines of general policy, strategic plans, etc., has been given them. All that has been refused is the right to dominate every detail of naval organization, and to the careful student of American naval history and of American institutions, it seems most fortunate that this has been the case.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

V. THE REALIZATION OF STANDARDS IN PRACTICE.

Mr. Emerson's series began in the issue of THE ENGINEERING MAGAZINE for July last. The topics and scope of the preceding installments are well defined in the opening paragraphs of this section.—THE EDITORS.

THE four preceding essays were general in character, showing that inefficiency is almost universal, that each nation has to some extent offset general inefficiency by good qualities of its own, differing from the good qualities of other nations, that American advantages in the past lay in great natural resources and in wonderful opportunities, pursued by keenly adaptable rather than specially skilled men.

Inefficiencies everywhere were ascribed to the primitive and elementary character of the directing organization, which has progressed very little beyond the military line evolved centuries ago, continuing unchanged even in armies until the latter half of the nineteenth century. To lessen inefficiency, not *less* of military line but *more* of supplementary staff was urged, and a specialized staff was indicated as the logical and inevitable forward step. It is the business of the staff, not to accomplish work, but to set up standards and ideals, so that the line may work more efficiently.

In attempting to better and strengthen great American repair and manufacturing plants, it was found necessary to use the perseverance of the British, the innovating logic of the French, the thoroughness of the Germans, the open-mindedness of the Japanese, and the adaptability of the American, and also to use staff first to determine and then to facilitate their attainments. The outlines of a successful attempt to apply staff and standards to a particular shop will now be described.

To enter a shop employing 2,000 men, each one doing an average of four different jobs each day, aggregating for all the men 8,000 separate tasks, these tasks changing from day to day, so that there is a total of tens of thousands of different tasks in a year—to be expected to standardize each and every one of the tasks as to both time and cost, is dismaying; not more dismaying perhaps than the proposition would have been to the primitive woman, whose hair was a mass of

matted tangles, that each and every one of the separate hairs of her head ought to be brushed and combed into its perfect place at least twice every day. It does not require much experience to distinguish between the well arranged head of hair and the matted one, nor does it require much experience to recognize in a machine shop the difference between what is and what ought to be.

In the particular shop under investigation there were great natural opportunities, such as abundance and steady supply of work, no financial worry as to income, the shop itself manned by an unusually fine, progressive, and experienced body of officials and employees. If under these conditions there was great inefficiency, great discrepancy between actual results and reasonable standards, the presumption is that the inefficiency was not due to conditions but to form of organization and to methods of administration.

The organization was the usual line organization; a president, a vice-president in charge of operation, a general superintendent in charge of all shops, a superintendent in charge of each large shop, a general foreman, foremen over each department, gang bosses directly over each subdivision of department. Each of the higher officials had his own individual staff, these individual staffs being weaker and cheaper towards the bottom, as when a foreman appropriated a machinist's helper to act as general utility assistant in the foreman's office. In two directions only were there embryonic staffs in parallel with the line, extending from the top to the bottom. One of these staffs was the detective service, whose operators, circulating among the employees in the guise of machinists, boiler makers, helpers, etc. reported through their own chief whatever they thought would be of interest to the head of the line. While the staff idea was here, while it was felt that the line by itself was inefficient, the two essentials of modern staff were wanting, since the secret operators were not only without standards but they were not helpful to the line members whose doings they were adversely reporting.* The other staff, the accounting department, was of very high character, had high ideals and exact standards, was in helpful touch from top to bottom with all members of the line. The head of the accounting staff was the general auditor, on the president's staff; under him were the division auditors, mechanical accountants, shop accountants, down to the time keepers and pay-roll distributors.

The accounting staff, fully organized and capable, proved of the greatest assistance as a type on which to model other staffs.

* A staff-supplemented shop would need very little detective reporting, since standards and their attainment would result in eliminating nearly everything of importance that detectives now report on.

Before beginning standardizing work a number of surveys were run through the shop to ascertain what was not covered by the existing line and accounting organizations. The first survey was to ascertain whether materials were being properly handled and checked; the second survey covered the condition of the machines and tools; in the third survey a number of labor assays or audits determined the relation between what men were actually doing and what they should do; the fourth survey showed as to a few operations the relation between current costs and standard costs, and the fifth survey the speed of movement of work through the shop. It does not follow because a shop is lax in one of these directions, that it is equally lax in others; it does not follow that being excellent in one direction it will be excellent in the others. Good work had always been an ideal in this shop, also a large output; but neither costs nor speed had been ideals.

The preliminary investigations revealed certain organic weaknesses of operation, due to the absence of ideals or standards and to the absence of a staff organization able to create and realize standards. To eliminate these weaknesses a staff was gradually created supplementary to the line. This staff organization would not have had necessary powers unless it had started very high up, the chief of staff in charge of standardizing and efficiency methods being on the vice-president's staff, without whose support in many an hour of need nothing could have been accomplished.

Under the chief of staff were various specialists, selected or promoted for their demonstrated experience, each one of these specialists becoming the head of a special staff line. The staff, in fact, was evolved not theoretically but in direct response to necessity.

The five different lines of preliminary survey were each made permanent fields of investigation and control.

A staff specialist was put in charge of everything appertaining to materials, his duties being to evolve methods which would always supply the right material at the right place, at the right time, in the required quality, minimum necessary quantity, and at lowest cost. Another specialist was put in charge of all matters appertaining to the maintenance and operation of machines and tools. A third and most important organization of specialists was given the duty of standardizing every task as to time; a fourth specialist took up the matters of standard costs, and a fifth specialist provided methods by which all work could be dispatched through the shop even more carefully and accurately than trains are dispatched on a railroad.

Although in this particular shop—a repair shop for a large corporation—costs had never been considered of commercial importance,

it was found absolutely necessary to provide a standard method of determining costs, applicable equally to the five-minute task of a single worker or to the month's output of the whole shop.

Costs can be subdivided into three divisions: (1) Material costs, (2) direct-labor costs, and (3) indirect or overhead or surcharge costs, this last division embracing everything that is not material or direct labor. Indirect charges (3) were subdivided into four classes: (1) Power (2) Maintenance (3) Rent (4) Administration. As a general production proposition, there is no difference between a man and a machine, the mere fact that the man is paid wages and the machine is virtually a slave, in which capital is invested, which has to be maintained and which in time perishes, being a financial and not a productive difference. Therefore all the expenses of power, maintenance, rent, and administration were subdivided partly to men and partly to machines, thus giving the foundation for a standard cost of any operation for any unit of time. Each of the four subdivisions of surcharge was put under the care of a staff specialist.

When a simple system of stating all costs—whether for a single task for man or machine, or for all a man's work for any period, or for all the work of a gang or department, or for a whole plant—is available; when this system permits parallel statement of actual and standard costs—then the whole problem is well-nigh solved, patience, persistence, fidelity and high ideals accomplishing the results, through the use of staff specialists.

The system under which costs were standardized will be made the subject of a separate paper, it being at present more important to see the results of this system, when applied to a single department of a great works, than to understand the system in its details.

DEPARTMENT F.

Statement of Condition for 12 Months Preceding June 30 on Basis of Standard Volume of Output.

	Actual.	Standard.	Reduction.
Costs per Hour.			
Direct wages	$36.93	$27.77	25 per cent.
Overhead or indirect expenses	18.98	11.11	41.5 per cent.
Machine expenses	48.94	29.17	40 per cent.
Totals	$104.85	$68.05	35.1 per cent.
Total Costs per Annum.			
Direct	$99,794	$75,000	$24,794
Overhead	51,255	30,000	21,255
Machine expenses	117,470	70,000	47,470
Totals	$268,519	$175,000	$93,519

This statement shows that whereas the actual cost per hour for a

given output averaged over a period of 12 months had been $104.85, it was determined by the staff officials that it should cost only $68.05, a reduction of 35.1 per cent.

This statement is remarkable. The actual expenses were those of the preceding twelve months. The standard expenses are theoretically predetermined by standardizing *not* the cost of work, but the efficiency of men, of machines and of methods.

The standard costs were those possible at the date the work was undertaken. By the time actual costs are reduced to $68.05 per hour new standards will have come into existence, making the standard costs as low, perhaps, as $60 per hour, so that the standard is always elusively ahead of the actual.

The president of the company does not need to see each month much more than this one statement (prepared however in the form of a flowing record) so that, at a glance, he can see the trend of progress. In this particular case a time limit was set within which the reduction was to be accomplished.

That the reduction from $104.85 per hour cannot be effected in a single month is obvious, and equally so that it ought not to take ten years. Whether it is to take a year or two years or four years depends solely on the willingness of the management. The shaded area in the diagram measures the exact cost of taking two years instead of one, and it amounts to about $100,000.

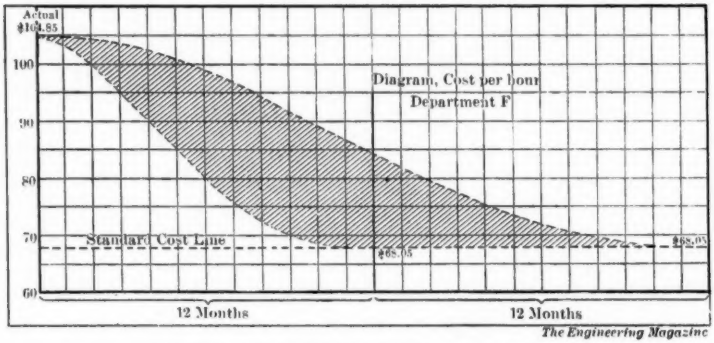


DIAGRAM SHOWING COST OF DELAY IN REDUCING COSTS TO STANDARD.

This epitomized statement of standard hourly cost is for a definite number of standard cost units, so that whatever fluctuations in kind or volume of work occur from month to month, standard comparisons hold good. The assumptions on which standard costs are based for Department F were as follows:—

Standard annual hours per machine	2,400
Standard annual hours of shop work	2,700
Standard value of equipment	$200,000
Standardized surcharges	$100,000

SUBDIVISION OF INDIRECT CHARGES.

	Actual.	Standard.	Reduction.
Power	$26,100	$13,000	50 per cent.
Maintenance	96,618	48,000	50 per cent.
Rent	14,587	12,000	17 per cent.
Administration:			
Direct	9,870	12,000	21.5 inc.
Indirect	21,550	15,000	30 per cent.
Total	$168,725	$100,000	40.8 per cent.

In pursuing the location of responsibility the indirect charges were apportioned partly to machine and partly to men.

	Actual.	Standard.	Reduction.
Overhead charges:			
Assessed to machines	$117,470	$70,000	40.4 per cent.
Assessed to men	51,255	30,000	41.2 per cent.
Total	$168,725	$100,000	40.8 per cent.
Direct pay roll	99,794	75,000	25 per cent.
Total	$268,519	$175,000	35.1 per cent.

Standard practice propositions are generally wrecked on the fact that to secure a net reduction of 40 per cent as to the whole, the cost of direct supervision is increased.

Managers are reluctant to incur an increased cost for direct supervision (in this case of 21 per cent or $2,130) to effect the 40 per cent net reduction amounting to $68,725, because they find it impossible to believe that so great a gain is attainable especially as it is not made the first month. They are certain that the very extensive staff organization must necessarily cause an unbearable increase in indirect expenses. This is not the case for three reasons:

1—A portion of the expense, the preliminary studies and investigations, are properly charged to capital investment as they have lasting value—as much as drawings or patterns, more than machines.

2—When the output of a plant aggregates $15,000,000 a year, with a pay roll of $3,000,000, the pro rata expenses of the general staff officials pro-rated to a department shop whose direct and indirect roll is only $150,000 a year is only 5 per cent of the total, so that if the general staff cost $40,000, the assessment to Department F would be only $2,000.

3—All the particular staff expenses are charged directly to the account benefited. If a staff advisor for, or a designer of, tools is employed his expenses are charged directly to the maintenance account.

The employment of so complete a staff will necessarily highly specialize operations, and economies result, not from an effort to secure them, but from an effort to do everything in a standard practical manner. Standard power conditions mean the same power with less coal and less power for the same output. As power happens to be one of the subdivisions of surcharge, the surcharge per unit is reduced without any thought or worry as to whether it is related to direct labor increases or decreases.

Standard maintenance conditions means far better tools for less cost, greater output from the same machines; and as maintenance is one of the surcharge accounts, when it decreases the maintenance surcharge per unit decreases. In Department F, actual expenses for power were $26,100; predetermined standard power expenses were placed at $13,000. This astounding reduction was realized in practice and was effected in the following manner: A power specialist is made responsible for the production of power. If the actual expense is $60 a year per horse power of 3,000 hours, every item of expense is analyzed, and it is ascertained that under standardized conditions the expense should not exceed $45, so this standard cost is set up for the man in charge of power production to aim at. On the other hand, the foreman of the department uses power, it being entirely beyond his control whether the rate to him is $60 a year or $45; but wasteful use of power is not beyond his control, so another staff expert scrutinizes every item of power use, ascertains that by the elimination of destructive frictions, leaks and wastes of various kinds, the total annual consumption of power can be reduced from 435 to 300 horse power; 435 horse power at $60 amounts to $26,100, but 300 horse power at $43.33 amounts only to $13,000. No one acquainted with the scandalous inefficiencies of the average factory power plant, consuming from 5 to 7 pounds of coal per horse power per hour, will question the ability to lower costs 28 per cent, and no one acquainted with the leaks of air and steam and water, leaks of light and heat, all the frictional losses due to lack of alinement, too tight belts, etc., will question the possibility of reducing power consumption 30 per cent. to 33 per cent.

The standards of $43.33 per horse power per hour, and of 300 horse power for the department, are by no means final. As long as it pays to follow them, further reductions are in order until standard minimum practice is attained. The essential of the system is that the item of power, as to production, distribution, and use, is set up monthly in two parallel columns, one showing actual, the other standard results, and the chief of staff in conjunction with chief of line

combine their efforts until facts and theory coalesce—until the victory is won, a victory not less inspiring because it is bloodless.

The item of maintenance is treated in exactly the same way. There must be a general supervisor of maintenance who standardizes the quality, custody, and issue of small tools, who remodels the larger machines, who anticipates breakdowns or repairs them so that the same collapse will never occur again. There is in addition all the economy that results from the careful and checked use of machines and tools. On even a larger scale than the one now being discussed, the staff assistant of the writer, in charge of maintenance of shop machinery and tools, effected the following results:

Year.	Output.	Expense.	Unit Cost.
1905	47,854	$486,620	$10.16
1906	57,760	376,106	6.51
1907	64,628	315,844	4.89

The reduction in unit cost is more than 50 per cent, the economy on a unit basis being more than $300,000.

In connection with this account my experience was amusing. The general superintendent was so alarmed at the direct staff expenses and the expenses of the improvements recommended by the staff, that he ordered a special account to be opened, in which they were all entered, so that at the end of the year he might point to this account as the cause of the, to him, inevitable and abhorrent increase. After absorbing all these special expenses, the actual net saving in money at the end of the year was $110,514, for a 20 per cent greater output.

It is unnecessary to discuss "rent" in detail. Standard expenses show slight reductions below actual owing to standardization of repairs, better custody of buildings, etc. There are occasions when rent can be very greatly reduced, by increased use of old instead of building new buildings, or the double-shifting of a shop. Using the building 20 hours a day instead of 10 hours will very greatly reduce rent per unit of output. The actual result of standardizing the legitimate cost of all these different items of surcharge is to reduce general expenses per unit or per hour about 40 per cent.

The method has been more fruitful than the usual methods of effecting economies in shop operation because an ideal standard cost is ascertained at which to aim, and realization is facilitated not by sub-dividing expenses to departments, thus frittering away responsibility, but by grouping all expenses under a few heads and putting each group in charge of a specialist, whose ideal is not to reduce cost of specific output but to standardize operations.

The problem of standardizing direct pay roll is much more difficult, as it involves the determination of a standard time and cost for

every task. For every work order issued to employees there is a determinable standard time. This time must be ascertained by the Taylor system of time studies. The specialist at the head of time-study work must be able at a moment's notice to state, before the work is begun, what the standard time is. The determination of standard time is a profession in itself at which specialists become very expert, so that on the average their determinations will not vary more than 1 or 2 per cent from ideal standards. Standard times may be anywhere from 10 per cent to 90 per cent less than actual times.

Standard time is lower than the time which a good worker would take to accomplish the task set. The worker is limited by conditions as they are, but standard time pre-supposes standard power and maintenance conditions—ideal, not actual, conditions for the worker.

It must be made pleasanter and more agreeable for the worker to attain standard output or to surpass it than to fall below it. His co-operation is secured by appealing to some of the strongest human instincts—some urging him forward, as ambition and hope, an increased wage rate set by himself, pleasure in the work; others impelling him from behind, as apprehension of discharge.

The result of standard efficiency in workers, coupled with standard other conditions, was to reduce direct-labor costs 25 per cent, an unusually small reduction.

I do not lay much stress on names or forms. I have been in shops of very high efficiency whose managers would not have understood the meaning of the word *staff*. Yet staff talent and staff activity were in full swing, the manager by natural intuition having selected foremen who had the double gift of line and staff ability. I also recognize that Mr. F. W. Taylor's shop organization based on functional foremanship is but another way of securing staff results, through staff specialists.

Whatever the names given to the line foreman or the staff specialist, it has been demonstrated over and over again, and on the largest scale, that staff investigation will show standard costs to be far below actual costs, and that predetermined standard costs can be attained through the direct and indirect assistance given to the line by the staff. The possible volume of the economy depends solely on the magnitude of the business, the rapidity with which economy can be effected solely on the courage and thoroughness with which the work is prosecuted. The labor difficulties are virtually nil, if there is persistent and conscientious effort to give the worker a square deal. The greatest impediment is the reluctance of the line to accept staff assistance, methods, and standards, including equity towards employees.

THE MOST IMPORTANT HYDRO-ELECTRIC INSTALLATION IN EUROPE.

By Enrico Bignami.

THE hydro-electric installation of Brusio at Campocologno (Canton Griscon), recently inaugurated, transmits the electric energy to the sub-stations of the *"Societa Lombarda per distribuzione di energia electrica"* of Milan, (which already disposes of 20,000 horse power from its installation at Virzola), at Lomazzo and Castellanza, Lombardy. The power transmitted, the length of the line, and the tension adopted, make it at the moment of installation the most important in Switzerland—and actually in Europe. It is undoubtedly the first of international character—for, according to conventions between the Swiss and Italian authorities, the electric energy produced in the Swiss canton is used entirely in Italy.

The water power supplying this installation is given by fall of the river Poschiavino flowing from the Lake of Poschiavo (Figure 1) at Meschino at the Swiss frontier. This lake, which has an area of about 2 square kilometres and a depth of 80 metres (260 feet), besides being an excellent basin of decantation, serves as a reservoir in times of low water; for according to the concessions, the water may be raised 1 metre above, and lowered 8½ metres below, the normal level. There are thus 17,000,000 cubic metres of water for disposal in times of low water. The lake is closed at some metres from the outflow by a sluice (Figure 2) by means of which the level of the lake can be raised 1 metre.

The water is taken out of the lake by a siphon, which leads it through a tunnel (Figure 3) cut through the solid rock, for a distance of 5 kilometres (3.12 miles) and reaches a storage basin (Figure 5) 435 metres (1,450 feet) above the central station. Six pressure mains of an exterior diameter of 800 millimetres (31½ inches), lead the water to a special building where are valves and penstocks to equalise the pressure (Figure 6) and from thence to the central station, situated on the Swiss-Italian frontier. The length of each main is about 1,350 metres (4,500 feet). They are composed of riveted tubes for pressure up to 20 atmospheres, and welded tubes for higher pressures. The walls increase from 6 to 23 millimetres in thickness,

the exterior diameter of the tubes being constant. At every change of inclination the mains are fixed in blocks of concrete, but they rest freely on the foundations, so that they can withstand changes of length. The pressure mains enter the central station of Campocologno (Figure 4) at right-angles to their axis, and after having passed a valve chamber, enter the turbines which are coupled in pairs to one main. In the valve chambers all the mains can be joined to a collector. The mains are provided with everything which will protect them from damage. The opening of the intake of water can be worked electrically from the central station. Expansion joints allow slight extension. Along the pressure main is a cable railway worked by an electric motor.

The necessary power during the period of construction was given by a small central station of 500 horse power, which was made solely for this end, but which will be allowed to remain for the future with a view to furnish the necessary power to light the central station, work the cranes, machine tools and pumps. The water power of this central station is given by the Sajento. The central station of Campocologno is a building 104 metres (334 feet) long, 21 metres (70 feet) wide and 15 metres (48¾ feet) high. It is divided in three parts (Figure 7)—the machine hall, 104 metres (334 feet) long, 16 metres (52 feet) wide, and 15 metres (48¾ feet) high; the room for switchboard and bus-bars, equally long, but 4 metres (13 feet) wide; and the building for offices and feed lines of the valley of Brusio and of the Bernina railway. The machine hall has room for 12 groups of turbines coupled to three-phase generators (Figure 8) each of 3,000 horse power; and 4 groups of turbines coupled to constant-current generators each of 225 horse power. For the use of the machines there is a 25-ton electric crane.

The turbines are Pelton wheels regulated automatically. The large ones are 3,000 to 3,500 horse power, with 375 revolutions per minute; the small ones 225 horse power, with 430 revolutions. They were constructed partly by Escher, Wyss & Co., of Zurich, and partly by Piccard, Pictet & Co., of Geneva. Each turbine is coupled to the electric machine by a Zodel-Voith elastic connection.

The three-phase generators are made after the system of alternate poles with fixed high-tension coils and with moveable exciting coils. The stator is in two parts, and the high-tension coils are placed in half-closed grooves lined with micanite. The rotor is of steel in one piece, and has on the cast-iron poles the exciting coils, which consist of copper ribbons. The normal power of the machine is 3,000 kilowatts and the normal tension 7,000 volts, with 50 fre-

FIG. 1. THE LAKE OF POSCHIAVO.
FIG. 2. HEADGATES AT POSCHIAVO.

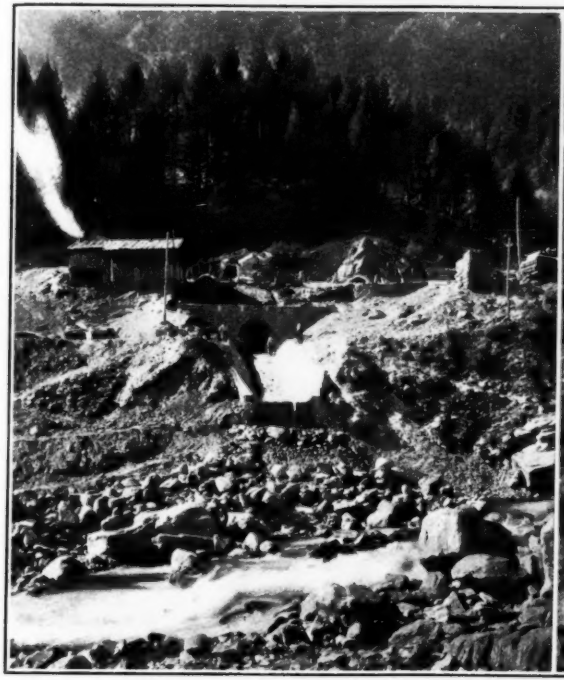


FIG. 3. TUNNEL OPENING INTO THE CHARGING BASIN.

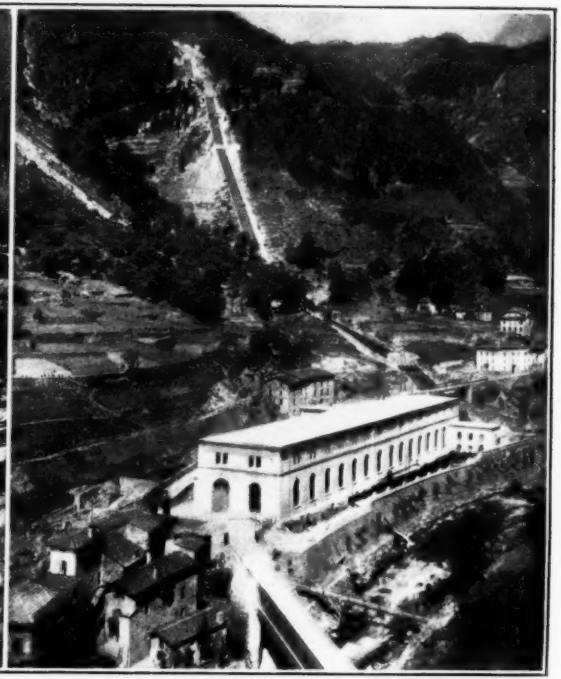


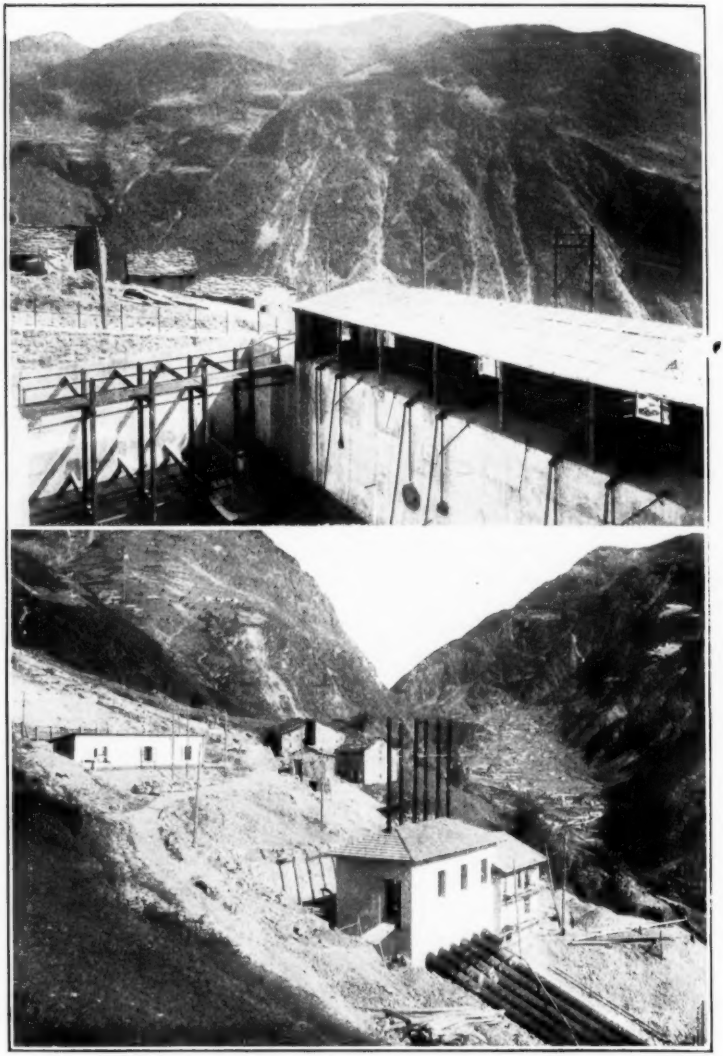
FIG. 4. CAMPOCOLOGNO STATION.

quency. It can, however, be regulated from 6,300 to 7,800 volts in order to compensate for losses on the line.

The continuous-current machines have a power of 150 kilowatts at 115 volts. Each at the same time serves for the exciting of four generators with 25 per cent. of surcharge and 0.7 as factor of power.

While, till now, in central stations, it has been the endeavour to concentrate as much as possible all the apparatus of control and command on one switchboard, here they have tried to decentralize, for each three-phase generator has a switchboard to itself (Figure 9). And that is considered as an advantage for the connections of the switchboard, as well as for the safety of working, so that a disturbance on one board does not extend to others. In spite of this the unity of service is maintained, because the entire installation can be seen at a glance from a distributing column placed before the exciting switchboard, whence the tension of the whole installation can be regulated. This central column has a voltmeter intercalated in each half of the central station and a commutation amperemeter, on which can be read the current of each machine, and an amperemeter for the line going to transforming station at Piattamala. The regulators of each exciter can be coupled, and by means of a wheel their tensions can be regulated from the central column, and consequently the tension of the whole installation.

Each switchboard generator forms a circuit by itself. Opposite the machine is the space where are the instruments and levers of control for the interrupters and regulators. The apparatus is placed in the bus-bar chamber, separate from the machine hall. Each switchboard, besides the necessary apparatus for use and for putting in parallel, has also an oil interrupter worked by hand as well as automatically with a relay, and a de-exciting switch, putting the exciting coil in short circuit by the introduction of an auto-inductive resistance (Figure 10). This switch is connected electrically with a high-tension interrupter, in such a way that the automatic interruption of the latter attracts to itself the former. By this means all damage is prevented from a contingent acceleration of the machine due to a sudden discharge, for the generator has only this acceleration to support, as increased tension is excluded. The position of closed or open interrupter is indicated by small signal lamps. All the instruments of the switchboard for the high tension are connected to the high-tension lines with tension and current reducers. The putting in parallel with the other machines can be done on the same board. Each switchboard is enclosed on its sides by diaphragms of concrete, and in front by an iron door. In the same way on the inside of the



FIGS. 5 AND 6. DETAILS OF CHARGING BASIN BUILDING, WITH STANDPIPES FOR EQUALIZING PRESSURE.

switchboard, the part for the high tension is separated from that for the low tension by fireproof walls. The upper covering is made from a sheet of marble. The switchboard can be disconnected from the bus-bars by means of cut-outs, which being removed the examination of the switchboard presents no danger even when working.

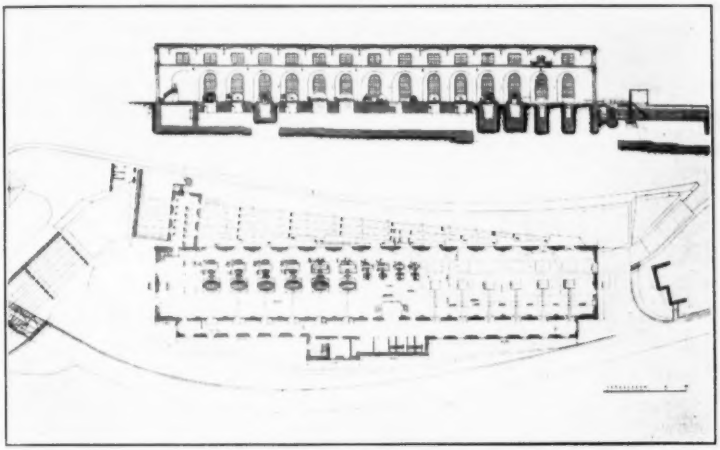


FIG. 7. PLAN OF THE CAMPOCOLOGNO STATION.

In the bus-bar chamber, which is divided into two floors, below are the exciting bus-bars, and above those for the three-phase current. The installation is entirely divided into two equal parts, each consisting of six generators and exciting dynamos, which work independently of one another, but which can always be put in parallel. This division allows one-half of the central station to supply the sub-station of Lomazzo, while the other half supplies the sub-station of Castellanza. The first three generators on the left side of the central commutation column can be joined to the separate bus-bars, and be excited by a special dynamo; they are intended to supply the energy for the valley of Poschiavino, and for the use of the Bernina railway.

The tension transformers are at some distance from the central station of Brusio and are situated in the sub-station at Piattamala, which is on Italian soil. The transmission line from the central station at Campocologno to the sub-station at Piattamala, a distance of 600 metres (1,968 feet) was one of the most difficult problems. An aerial line would have required 36 wires for the transmission of about 2,400 amperes and its up-keep did not promise too much safety on account of the possibility of falls. The use of underground cables would have involved an enormous cost, and the safety of the installa-

tion would not have been guaranteed. The most natural solution was the digging of a tunnel between the two stations, in which the lines could be placed, but this solution encountered the greatest difficulties, for the tunnel crosses the frontier, and it was believed it would be used for smuggling. The two lines of the tunnel form a direct connection with the two bus-bars of the parts right and left of the central station, and as such are installed there. On each side of the tunnel there are three lines of copper bars, one above the other, each 150 millimetres square; the joints are united by screws. The bars are mounted on triple petticoat insulators, which are fixed on straight supports between two U-shaped irons and serving at the same time to support the concrete diaphragms between the different phases.

The lines right and left are separated from the central passage by a trellis of iron wire, so that the passage is always free from danger. The tunnel is 625 metres (2,049 feet) long, 2 metres (6½ feet) wide, and 3 metres (9 feet, 10 inches) high, and is watched night and day by custom-house officials. Most of the tunnel is dry; at one point only was found a spring of water, which has been used to cool the transformers and for the water lightning protectors. The tunnel ends in the basement of the transforming station at Piattamala,

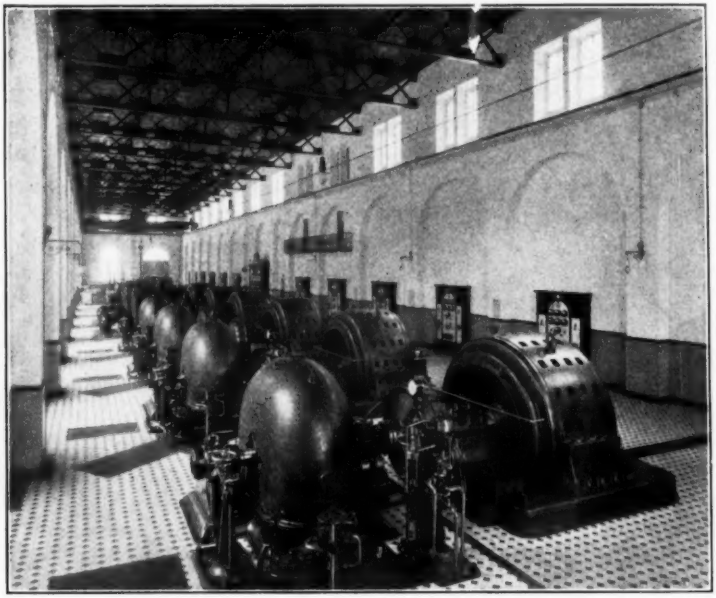


FIG. 8. MACHINERY ROOM, CAMPOCOLOGNO STATION.

to which the energy from Campocologno is carried at a tension of 7,000 volts. The station is constructed to receive 24 monophase transformers of 1,250 kilowatts each (Figure 11), which, star connected in sets of three, increase the tension from 7,000 to 45,000 volts of three-phase current. The transformers are oil and water-cooled. The station is 55 metres (180 feet) long, 21 metres (68 feet) wide, and 8 metres (26 feet) high, and towards Toriano has two towers for the exit of the lines. It is connected with the high road by a stone bridge capable of carrying the heavy transformers (Figure 12). The station has the duplex design characterizing the whole installation and is divided lengthways in two symmetrical parts, which can be at any time electrically joined. The lines leaving the tunnel enter the so-called measuring room, where the energy coming from Brusio is measured. Each half is provided for this purpose with three amperemeters, one per phase, a commutation voltmeter, a registering voltmeter, and two registering wattmeters wired in series, of different origin and construction, which are reciprocally controlled. Finally in this room are installed three ammeters and a commutating voltmeter for the two lines, beginning at 50,000 volts, so that the working of the whole installation can be controlled from one point. From the measuring room the lines descend to the rooms below, situated right and left of the transformer house, and from these pass to the transformers themselves. The lines passing from the transformers, after having passed the interrupter, are joined to 50,000-volt bus-bars placed on the first floor (Figure 13).

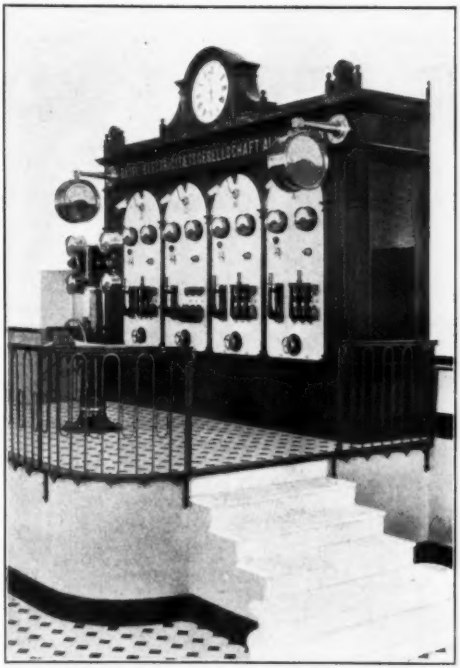


FIG. 9. SWITCHBOARD AND DISTRIBUTING COLUMN.

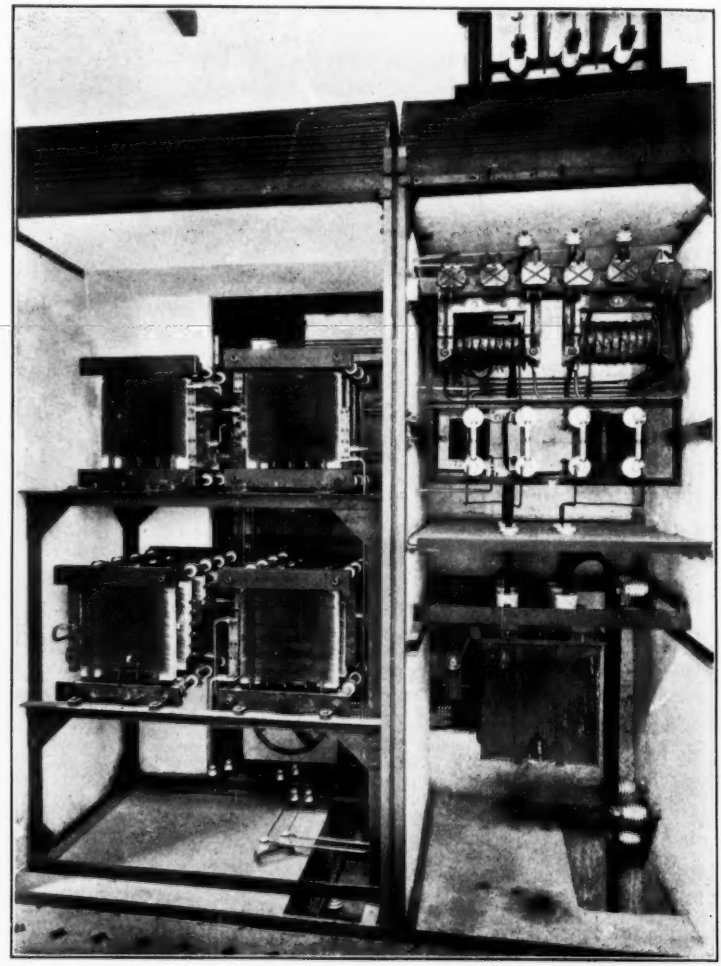


FIG. 10. RESISTANCES, SWITCHES AND CIRCUIT BREAKERS, CAMPOCOLOGNO STATION.

Each group of transformers has a tripolar oil interrupter for 70,000 volts, and a unipolar oil interrupter for each phase for the high tension. All the interrupters of one group are mechanically united with one another, and can be opened automatically by a retarded induction relay. Each group of three ammeters has small signal lamps to show if a group is joined or not. In front and behind each transformer are choking coils, and the neutral wires common to the groups

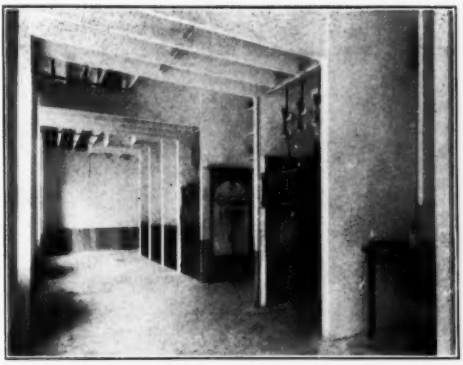


FIG. 11. TRANSFORMER ROOM, PIATTAMALA.

are brought to earth after having passed from horn-shaped lightning protectors. Each group can be separated on both sides by cut-outs and so placed out of tension. All the lines are separated by walls and also all the apparatus of each phase, except those of the 70,000 volts, work in company with their interrupter. The transformers are mounted in the central building of the station, the whole length of which can be seen from the measuring room. Each transformer is placed in a fireproof chamber (Figure 14), which can be completely closed, and is provided with a ventilating chimney, which in case of fire acts as a vent of the smoke of the oil. The transformers rest on toothed rails on which they can be easily moved. Between the two series of transformers are two guides, one on each side, on which they can be

FIG. 12. BRIDGE AT THE PIATTAMALA STATION.

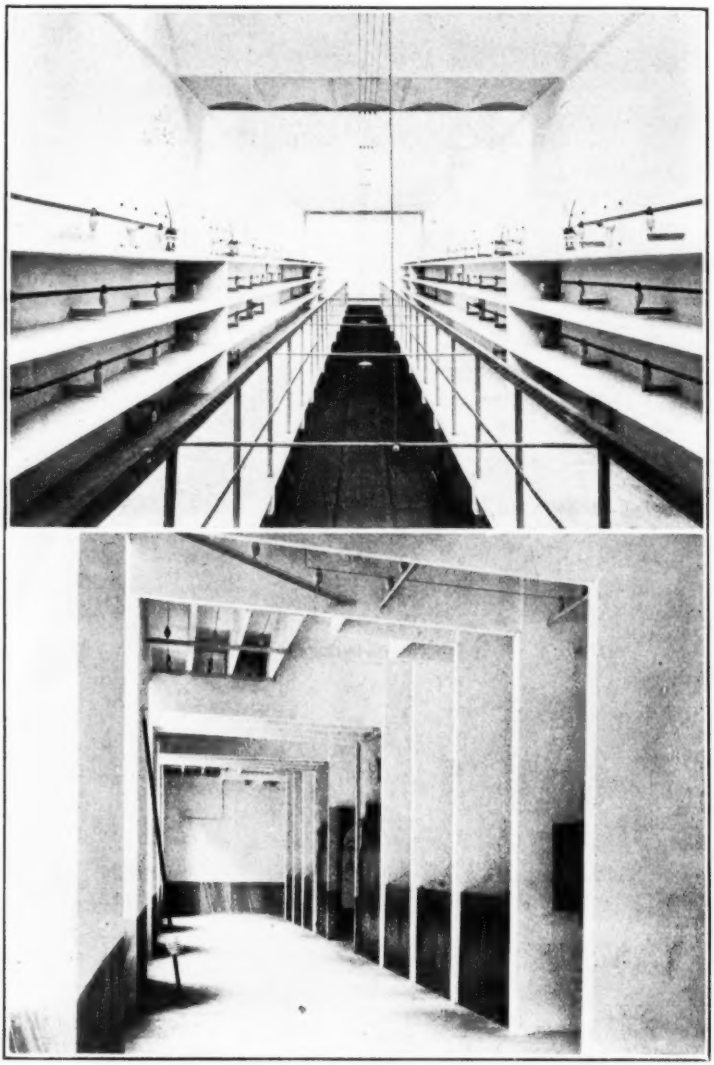


FIG. 13. BUS BARS AND COLLECTORS, PIATTAMALA STATION.
FIG. 14. FIREPROOF TRANSFORMER ROOM, PIATTAMALA.

moved into the space between the two towers for the outgoing lines; there is also a 10-ton crane for handling the machinery.

The two high-tension bus-bars lead first to the general interrupter of the exit lines, which consists of three large oil interrupters coupled together; and after passing apparatus protecting against lightning and elevation of tension, go to the outside line. Although the central station at Campocologno is not so protected, the sub-station at Piattamala is well provided. In correspondence with each feed line are mounted reaction coils, which prevent any superelevation of tension. There are protectors *à rouleau* for the discharge of high-tension due to changes of induction or static, and by protectors of jets of water, by means of which the lines are earthed by a continuous flow of water, and the superelevation of tension independent of the working

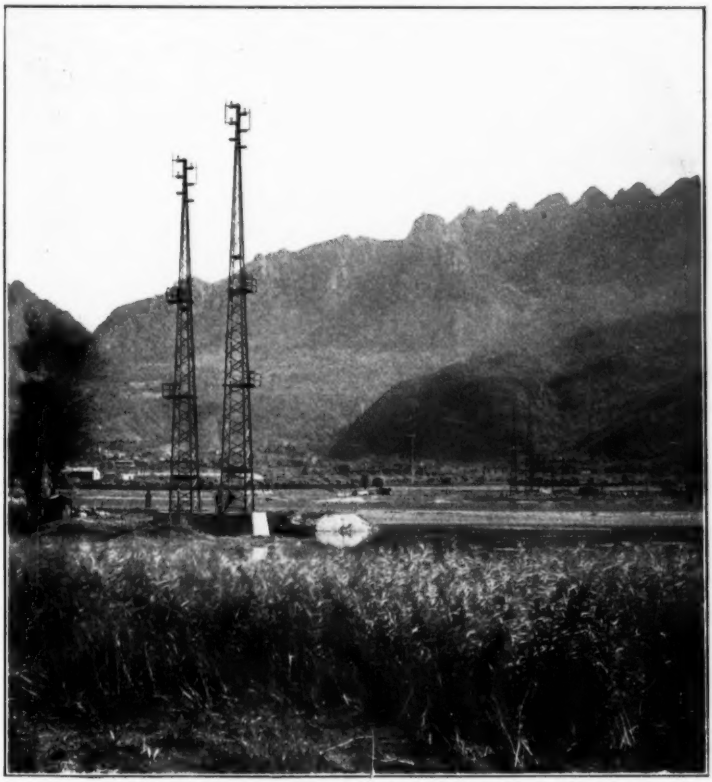


FIG. 15. AERIAL TRANSMISSION LINE LEAVING PIATTAMALA.

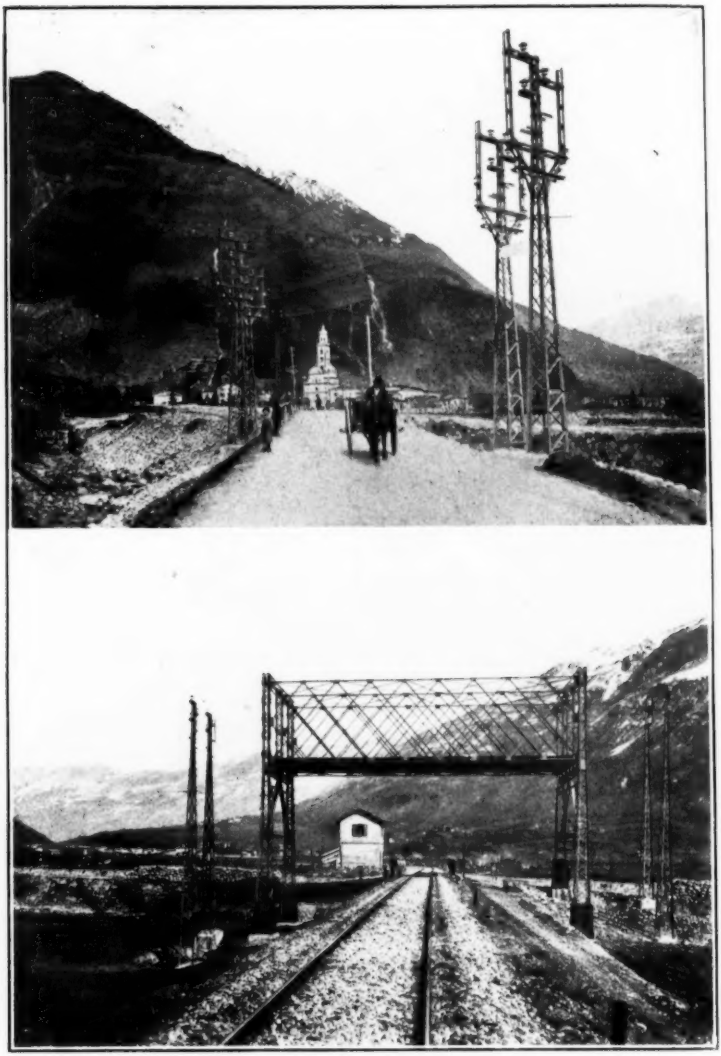


FIG. 16. TRANSMISSION LINE CROSSING THE HIGHWAY NEAR MADONNA DE TIRANO.
FIG. 17. TRANSMISSION LINE CROSSING THE RAILWAY NEAR TIRANO.

produces no damage. Finally, horn-shaped lightning protectors with water resistances are provided against the atmospheric discharges. Each protector can be separated from the line.

The ammeters inserted in the water earth lines, beside serving for the control of the current passing through the jet of water, also for the state of isolation of the overhead aerial line current and tension transformers, are inserted in each line of which the secondaries lead to instruments placed in the measuring room. The lines can be separated by cut-outs, and by cut-ins can be earthed for the safety of workmen.

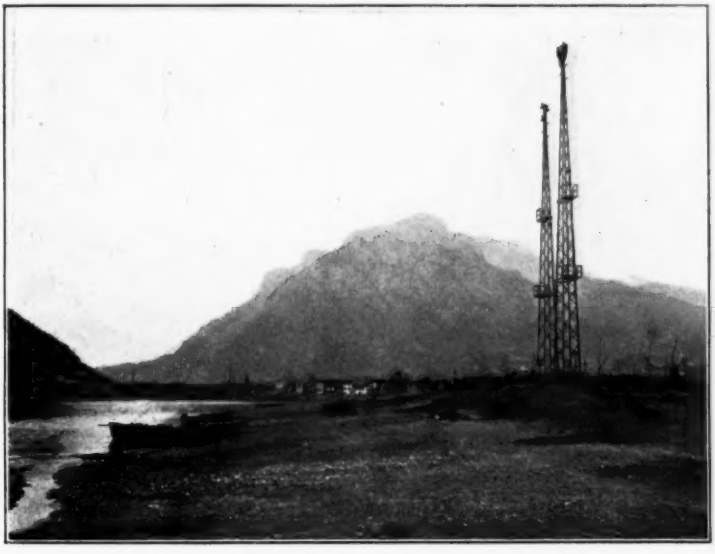
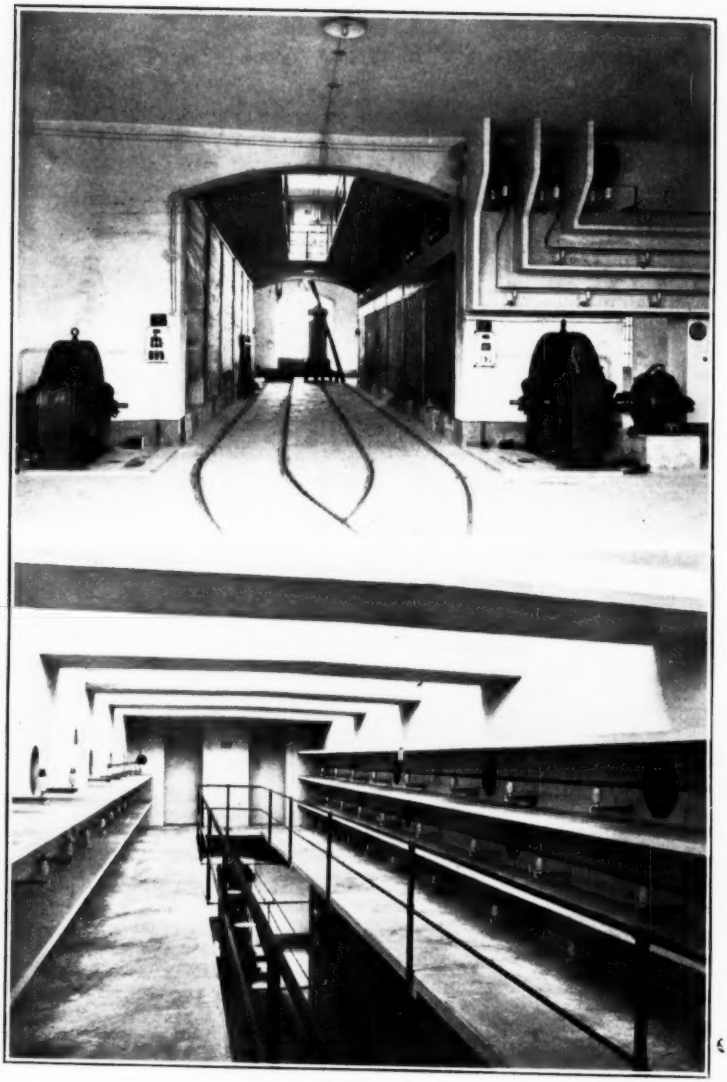


FIG. 18. CROSSING OF THE RIVER ADDA, NEAR LECCO.

The line leaving Piattamala (Figure 15), to the sub-station at Lomazzo is 147 kilometres (81 2/3 miles) long. From here to Castellanza (near Legnano) is 19 kilometres (11⅞ miles) long. It follows the neighboring mountains in the section Sondrio-Colico (Figures 16 and 17), and ends across the Val Sesina at Lecco (Figure 18), on the lake of Como. From there it follows the plain. Complete, it consists of four parallel lines of three copper cables, 105 square millimetres in section, mounted on two parallel rows of iron lattice poles, six wires on each pole. The rows of poles are paralleled and from 4 to 5 metres (13 to 17 feet) apart. In places where they are not so wide apart from condition of the ground, the poles of one



FIGS. 19 AND 20. INTERIOR OF LOMAZZO STATION.

row are higher than those of the other by several metres, so that approach of the two lines is prevented. The average height of the poles is 12 metres (39 feet 4 inches) and they are 100 metres (328 feet) apart. At some places the height of the pole is as much as 30 metres (98 feet), and crossing certain valleys as much as 400 metres (1,312 feet) apart. Each wire is mounted on porcelain insulators tested to 100,000 volts and placed 1.20 metres (47¼ inches) from each other. They are fixed on straight supports fixed on blocks of wood carried on double iron supports. The current when running without load measured at the beginning was about 14 amperes under 50,000 volts tension for each line of 3 wires. For the safety of the line there have been placed at Sondrio, Cortenova, at the commencement of the passage across the mountains, at Lecco, the commencement of the plain, and at Gerenzano, cabins with lightning protectors and safety apparatus against superelevations of tension. In these cabins are fitted U-shaped lightning protectors, protectors *à rouleaux*, and water earth lines.

The sub-station at Lomazzo constitutes the starting point for the distribution of the power. It consists of an H-shaped building 36 metres (124 feet) long, 17 metres (55¾ feet) wide in the middle, and 10 metres (32 feet) high. It is arranged for the reception of six monophase transformers, each with a capacity of 1,250 kilowatts to step down from 40,000 to 11,000 volts, and six three-phase transformers of 500 kilowatts from 11,000 to 20,000 volts (Figures 19 and 20). At present there are installed three monophase transformers of 1,250 kilowatts (Figure 21) and three three-phase

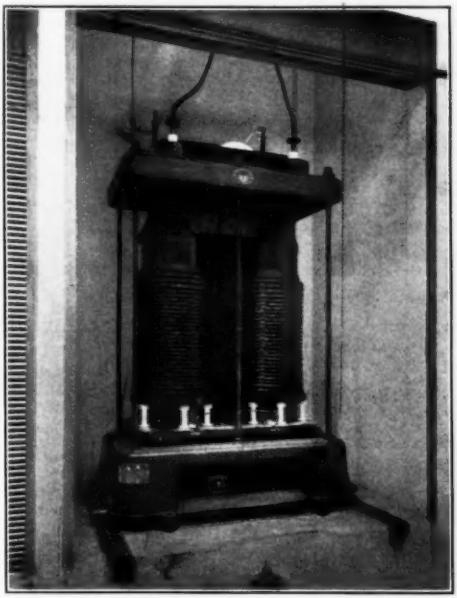


FIG. 21. 1250 KILOWATT MONOPHASE TRANSFORMER, WITH FORCED VENTILATION.

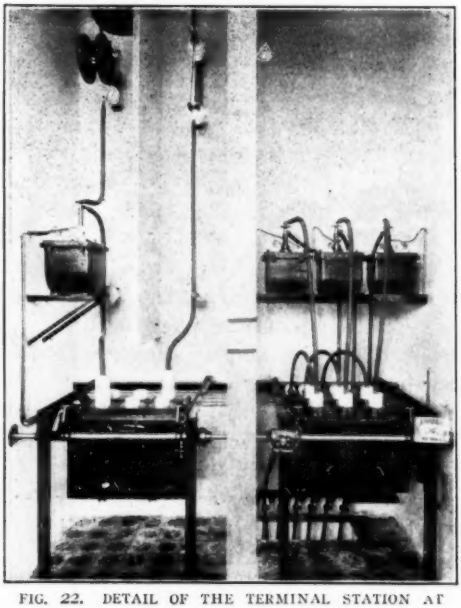


FIG. 22. DETAIL OF THE TERMINAL STATION AT CASTELLANZA.

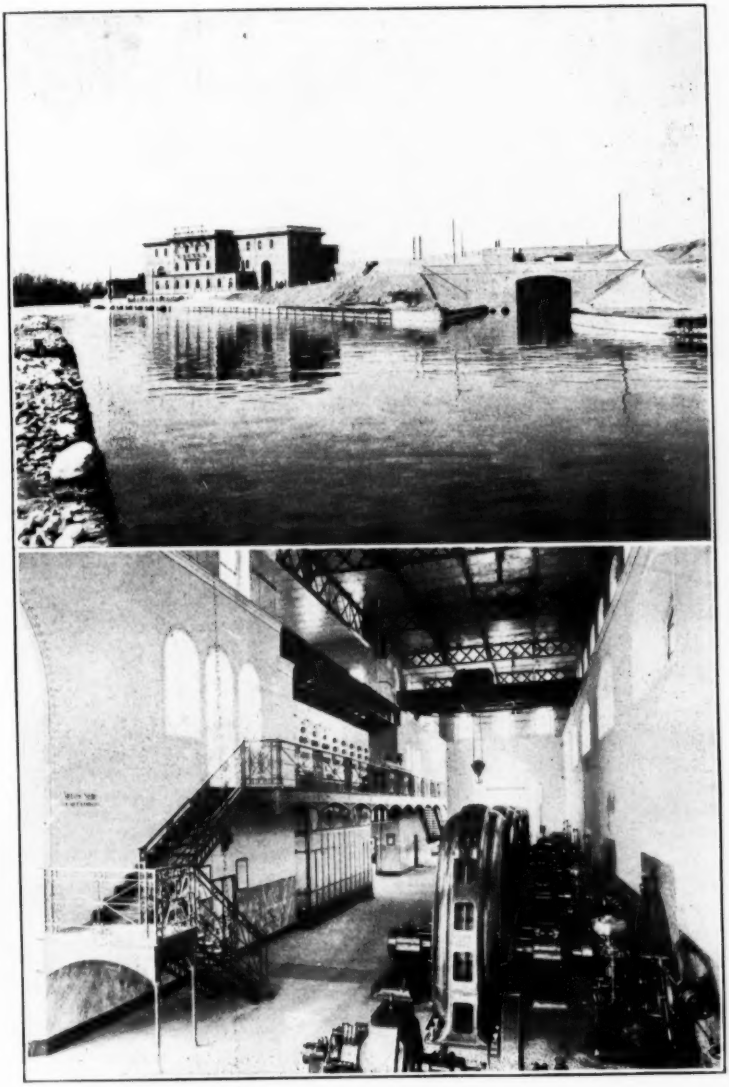
transformers of 500 kilowatts. A monophase transformer is in reserve, and three others will be installed next year.

The station is remarkable for the lines. The two lines coming from Piattamala, called A and B, are introduced there, although generally only the line A supplies Lomazzo, whilst the line B is intended for Castellanza. The third line, C, joins Lomazzo to Castellanza and these connections are possible:

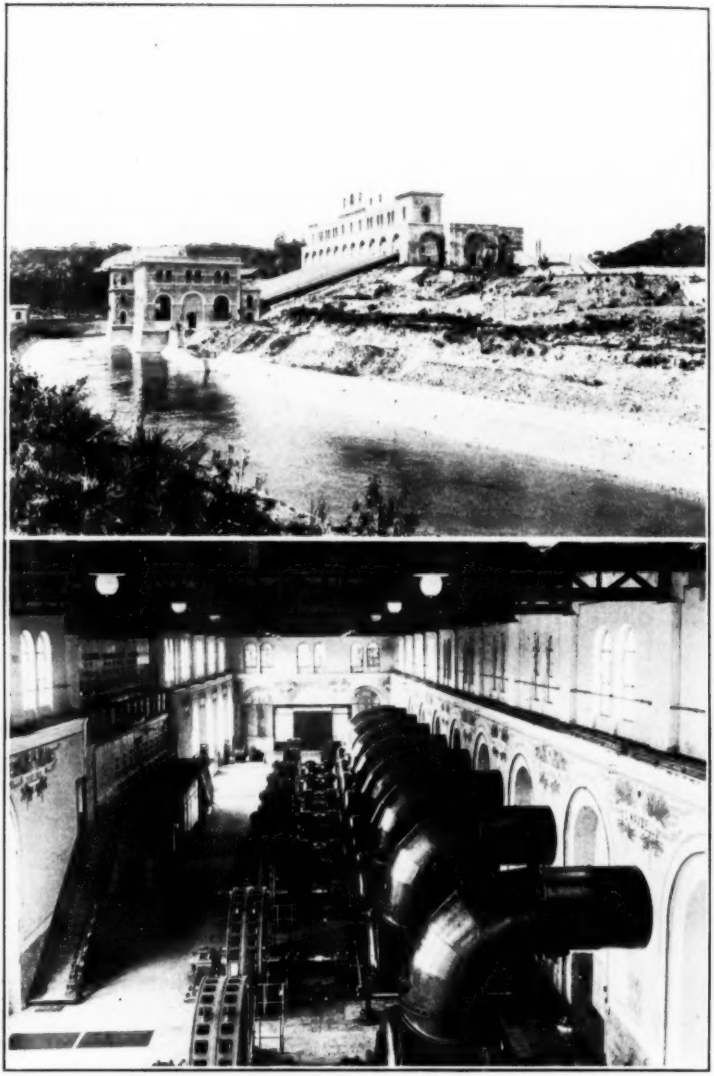
A supplies Lomazzo—B (by means of C) Castellanza.
A supplies Lomazzo and Castellanza.
B supplies Lomazzo and Castellanza.
A supplies Lomazzo or Castellanza.
B supplies Lomazzo or Castellanza.
C supplies Lomazzo.

In the last case the power is supplied by the central steam station of the above mentioned "Società Lombarda" at Castellanza, which constitutes the reserve for the hydraulic installations at Turbigo, Vizzola, and even at Brusio. The last combination can be arranged so that there can be a supply at 40,000 volts, in case of serious interruption, by means of high-tension transformers. Or when a longer interruption is feared, the supply can be made directly at 11,000 volts by the generators at Castellanza by means of two hydraulic installations. The working at Lomazzo is thus fully protected.

Another feature of this station is that all the transformers in use are of the dry type with ventilation of compressed air. At present they are the largest transformers for such a high-tension ventilated by compressed air.



FIGS. 23 AND 24. EXTERIOR AND INTERIOR, TURBIGO STATION.



FIGS. 25 AND 26. EXTERIOR AND INTERIOR OF VIZOLA STATION.

The part A of the station at Lomazzo is similar to that at Piattamala. The part B serves for six three-phase transformers of 11,000 to 19,000 volts, by means of which it is supplied by a line of 50 kilometres (30 miles) leading to Como.

Other lines lead to different large factories. The station is plentifully supplied with lightning protectors, and safety apparatus against superelevation of tension, namely, the lines A, B and C, as well as the other exit lines.

In the terminus station of Castellanza (Figure 22) part of the steam central station has been reserved for a transformer station. Owing to very limited space, the lines and apparatus were necessarily arranged on three floors, the height of the central station lending itself readily for this purpose. The station is also divided into two parts. The left side is furnished with three transformers of 1,250 kilowatts. On the upper floor are the attachments of the line, the cut-outs, and the short circuiter for the entering lines, and lightning protectors *à rouleaux*. On the middle floor are the bus-bars, and on the lower floor the distribution and the lightning protectors of water jets. The chambers for the transformers occupy two floors and are the same as those at Piattamala. The transformers are oil, water-cooled. The distribution corresponds to that at Piattamala. The right side is at present being built. It is similar to the left side, but has not the apparatus for the protection of the lines. The two parts are joined together by a gallery. The horn-shaped interrupters are placed in a special chamber, where later the lightning protectors will be placed.

The central station at Campocologno and all the other stations were built from the plans of the Alioth Co., of Münchenstein (Bâle), which has supplied and mounted all the electrical parts of the entire installation. The whole work was finished in 26 months, the mounting of the electrical part requiring 14 months.

On account of the failing of the water of the central stations at Turbigo (Figures 23 and 24) and Vizzola (Figures 25 and 26) the installation commenced work without any previous trial, and worked from the first without any interruption or inconvenience. New demands, made by the communes and private consumers in the large district supplied by the "Societa Lombarda," follow without interruption and prove the foresight displayed in incurring the large expense of an installation on the other side of the frontier. The conditions under which the installation was made, as well as its power, allow it to be called the most important hydro-electric installation in Europe.

THE GOLD FIELDS OF WEST AUSTRALIA.

By Arthur Selwyn-Brown.

Mr. Selwyn-Brown's discussion of West Australian gold mining in this number reviews the development, geological features and production of the principal fields. A subsequent article will deal with the special milling and metallurgical methods employed in the treatment of the ores. THE EDITORS.

AN enormous amount of gold has been added to the world's treasuries during the past sixty years. The gold fields of Australia and the United States alone have produced in this short period more than $6,000,000,000 worth. The significance of these figures is emphasized when we remember that before the discovery of the California gold fields in 1848 the world's gold reserves amounted to less than $4,000,000,000. The immense production of gold in recent years has resulted in a correspondingly large expansion in commercial credits which in turn have been important factors in assisting the marvellous advancement in commercial activities and in human prosperity witnessed throughout the world in the past half-century. This glorious period is destined to become an important epoch in history. As history is now democratic, the great gold fields, which contributed the gold from which so many blessings have been derived, and which so appreciably promoted the advancement of trade and commercial power and the comforts of mankind, will, doubtless, attract the attention of historians as much as the deeds of warriors and churchmen did in mediæval times. The gold fields of West Australia are among the youngest and richest of all. They have added in the last twenty-two years over $400,000,000 to our gold supplies, and their histories are brimful of interest.

The development of West Australia has been unique in many respects. This State has always possessed extraordinary and mysterious attractions for explorers and pioneers. In consequence of this it has experienced an unusually romantic history. From the time Juvenal described its "*Rara avis in terris nigroque simillima cygno.*" or black swan, until about 1511, when it was visited by Portuguese sailors, we definitely learn very little about it. There is some evidence to show that not infrequently Oriental navigators visited its shores to secure cargoes of sandal wood, pearls, fish, and other products. In the six-

GOLDEN HORSESHOE HEAD WORKS AND MILL.

teenth and seventeenth centuries Portuguese, Spanish, Dutch and English sailors, who roamed the eastern seas, occasionally ran down the western shores of Australia for various purposes. These men frequently explored and described the country. In many of their accounts wonderful tales were told of gold discoveries. It was such tales that earned Australia the prophetic titles of *Provincia Aurifera*, and *Terra Australis Aurifera* under which it was marked on the early maps. The gold finds they described, as well as those of the buccaneers, were, doubtless, to a large extent pure fiction. The persistency of many of the accounts of the occurrence of gold nevertheless, evidently indicates that some gold was discovered in West Australia at an early date. It was not, however, until as recently as 1883 that payable gold was actually discovered. In that year Messrs Hall and Slattery, while prospecting in the Kimberley district, in the northwestern portion of the State, found payable alluvial gold in a locality previously indicated as auriferous by E. T. Hardman, the Government geologist. When this discovery became known throughout Australia a great gold rush set in which led to the discovery of gold and the development of gold-mining industries practically all over the State.

Topographical and Geological Features of West Australia.

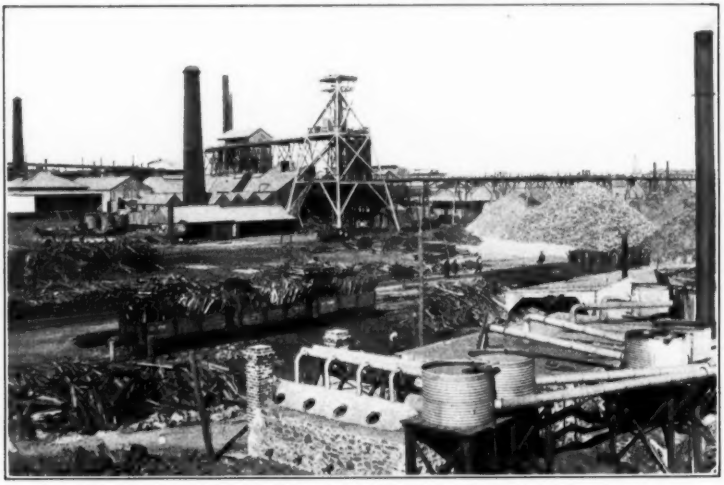
West Australia may be divided in regard to its broader topographical features into the three following divisions:

1.—The coastal plain, consisting of a fringe of strata around the coast having a slight tendency to slope seaward. Sandstones, con-

glomerates, shales, clays, and other detrital formations constitute its geological features. This plain has an average width of about 70 miles, but in the south-eastern portions of the State, in the vicinity of the Great Australian Bight, the coastal plain extends inland a distance of about 200 miles from the sea. The inner rim of this plain rises to an elevation of 600 feet above sea level.

2.—The coastal plain is separated from the plateau and plains of the interior by numerous mountain chains having an average elevation of 1,200 feet. This mountainous country is composed, largely, of granitic and metamorphic rocks. Many important mining centers are located in this belt.

3.—The three topographical division comprises the interior districts of the State. This has not yet been thoroughly explored. Broadly speaking, it is an extension of the broken tableland. It possesses numerous isolated hills and ridges of granitic and metamorphic rocks which are often separated by sand plains. In the sand plains numerous salt-water marshes and brine lakes occur. This division contains no important rivers and has only a slight rainfall.



GENERAL VIEW OF THE GREAT BOULDER GOLD MINES SURFACE PLANT.

West Australia possesses many singular geological features. Three of these will be referred to—namely, the Archæan rocks, the amphibolites, and the laterites. These are prevalent on all the gold fields.

The Archæan rocks occur all over the State, and have a greater development there than in any other part of the globe. They are com-

posed chiefly of granites, gneisses, and schists which generally run in parallel belts striking towards the north or north-west. The most valuable mineral deposits are found in, or closely associated with, these rocks. Six main belts of Archæan rocks have been mapped. The first, known as the western belt, extends from the Murchison River to the south coast and underlies the coastal plains.

DUMPING PLANT AT THE GREAT BOULDER MINES.
The problem of handling the immense accumulations of dump matter is at present an important one on the Kalgoorlie field.

The Darling belt underlies the Darling Mountains and extends northwards from the south coast to the Murchison River, and thence north-eastwards to the Robinson Range. The third belt, measuring over 100 miles in width and composed mainly of granite, is known as the well belt, owing to the numerous natural reservoirs found in its depressions. The next parallel belt is the auriferous belt. This has an average width of about 35 miles. The Southern Cross, Mount Magnet, Cue, and other prominent Yilgarn and Murchison gold mining centers are situated on this belt.

The fifth, or Pilbarra, belt is also granitic. It is extensively exposed on the Pilbarra and other north-western gold fields. The remaining belt extends northwards from the Dundas Hills, traverses Coolgardie and Ularring to Nullagine, Egina and Mallina. These extraordinary Archæan belts are of great interest to petrologists and stratigraphical geologists. They, however, have not been scientifically investigated.

The amphibolites, called by the miners greenstones, are the principal ore-bearing rocks on the south-eastern fields. They consist of

much green hornblende and feldspar, and pass imperceptibly from red greasy clays into chlorite, hornblende and serpentine schists.*

The laterites are detrital deposits which cap the hills and ranges. They form prominent features in the landscape owing to their richness in iron oxides and their consequent coloration. These deposits are found all over the State. In some places they are auriferous and in others they are sufficiently rich in iron to be worked as iron ores.

Gold Production.

The gold production of West Australia from 1886 to April 30, 1908 amounted to 18,920,143 ounces fine, valued at $378,403,740. Of this amount 9,628,741 ounces, valued at $192,574,820, were exported, and 9,291,402 ounces valued at $185,828,040 were coined.

Table I. West Australian Gold Production, 1886 to April 30, 1908.

Year.	Fine Ounces.	Value.
1886	270.17	$5,400
1887	4,359.37	87,180
1888	3,124.82	62,500
1889	13,859.52	277,200
1890	20,402.42	408,040
1891	27,116.14	542,320
1892	53,271.65	1,065,420
1893	99,202.50	1,984,040
1894	185,298.73	3,705,960
1895	207,110.20	4,142,200
1896	251,618.69	5,032,360
1897	603,846.44	12,070,920
1898	939,489.49	18,789,780
1899	1,470,604.66	29,412,080
1900	1,414,310.86	28,286,220
1901	1,703,416.52	34,068,320
1902	1,871,037.35	37,420,740
1903	2,064,801.40	41,296,020
1904	1,983,230.07	39,664,600
1905	1,955,315.88	39,106,320
1906	1,794,546.60	35,890,940
1907	1,697,553.59	33,951,060
Total	18,363,787.07	367,276,620
1908, to April 30	556,355.59	11,127,120
Total	18,920,142.66	$378,403,740

The annual yields since 1886 are given in Table I. The proportional contributions of the leading gold fields, and the importance of West Australia as a gold producer as compared with the other States of Australia are graphically illustrated in Figures 1 and 2. West Australia now produces about $37,000,000 worth of gold annually.

* See the "Goldfields of Australasia" by Schmeisser and Vogelsang for an interesting account of the amphibolites.

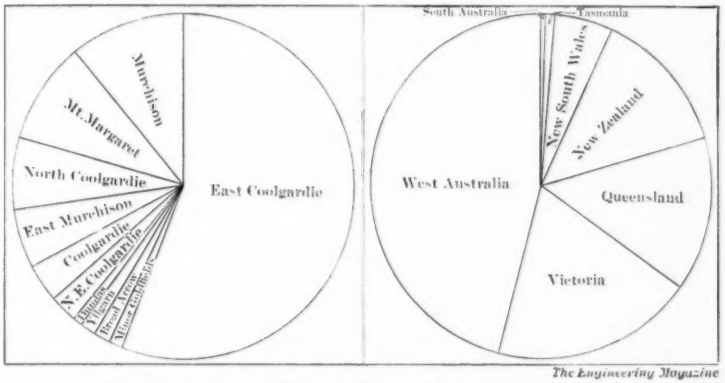


FIG. 1. CHART SHOWING COMPARATIVE PRODUCTION OF THE PRINCIPAL GOLD FIELDS OF WEST AUSTRALIA.

FIG. 2. CHART SHOWING COMPARATIVE GOLD PRODUCTION OF THE AUSTRALASIAN STATES.

Characteristics of the Principal Fields.

The State has been divided for administrative purposes into numerous mineral districts which include twenty gold fields. The principal gold fields will be briefly described.

Kimberley.—The first payable gold strike in West Australia was made on one of the branches of the Elvire River. Later similar finds were made near the head waters of the Ord and Margaret Rivers. This is the most northerly of the gold fields. It is situated about 200 miles due east of the port of Broome, Roebuck Bay. It embraces an area of 33,000 square miles reserved for gold-mining purposes on May 20, 1886. Archæan crystalline schists, granites, and more recent volcanic rocks occur throughout this field. There are also many representatives of the Cambrian, Devonian, and Carboniferous systems. Very little mining is being carried on at present, but the field is exceedingly rich in minerals and at some future date will possess extensive mining industries.

Pilbarra.—The Pilbarra gold field was opened in 1889. It comprises an area of 9,480 square miles, situated on the north-west coast. Starting from the Fortescue River, its southern boundary, the field extends up the coast a distance of 250 miles. Granites and gneisses are the principal gold-bearing formations. Vast masses of sandstones, grits, conglomerates, and volcanic rocks overlie the Archæan rocks on the field. These recent rocks are known as the Nullagine beds, taking their names from the Nullagine River around which they are prominently developed and form remarkable scenery.

OUTLINE MAP OF THE WEST AUSTRALIAN GOLD FIELDS.

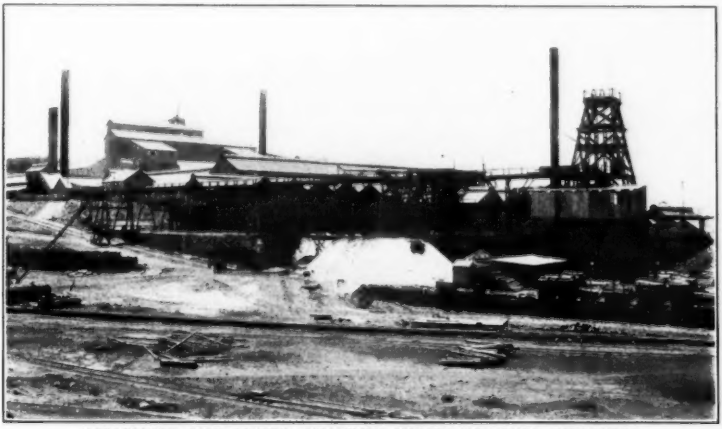
Quartz veins occur in great abundance all through the granitic and schistose rocks wherever they outcrop. The veins are usually small in width and of lenticular form. The field produced, between 1889 and 1907, 215,306 ounces of gold valued at $4,306,120. Pilbarra, Marble Bar and Nullagine are the leading gold-mining centers.

Gold occurs, and is being profitably mined, in conglomerate deposits of great extent, which bear a strong resemblance to the banket deposits of the Transvaal, in South Africa, at a point on the Nullagine River about 90 miles above its junction with the Oakover River. When mining costs are reduced, these deposits will be extensively mined.

Ashburton.—This field is situated along the Ashburton River. Commencing at a point on the river about 150 miles inland from the sea, it extends inland about 150 miles to the boundaries of the Gascoyne and Peak Hill gold fields. This field was proclaimed in 1890 and has an area of 15,000 square miles. It was famous early in its history for its alluvial workings. It gives promise now of becoming

an important producer of vein gold. Auriferous veins are being developed in a belt of country running from the junction of the Hardy and Ashburton Rivers south-easterly for a distance of 170 miles.

Peak Hill.—The auriferous territory lying at the head waters of the Gascoyne and Murchison Rivers was proclaimed the Peak Hill gold field in March 1897. It has an area of 12,194 square miles. This country embraces a portion of the coastal plateau. One of its singular geological features is a series of quartzite dikes, which are often of large size, trending in a north-easterly direction throughout the field. These dikes are auriferous in places. Many of them could be mined as low-grade ore bodies.



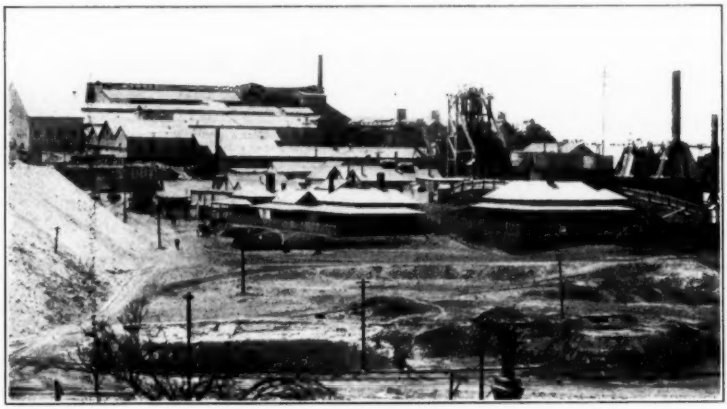
ASSOCIATED GOLD MINES, SHOWING SHAFT AND MILL BUILDINGS.

Murchison.—The Murchison gold field adjoins the southern boundary of the Peak Hill field, and contains an area of 20,000 square miles proclaimed in 1891. The geological structure of this district is remarkably uniform. A noticeable feature is the frequent occurrence of belts of banded hematite-bearing quartzites. These extend in a roughly parallel series many miles in length which outcrop in rough serrated ridges in a diorite formation. These great lodes are generally auriferous. Some day, doubtless, they will be mined very extensively. At the present time the Great Fingall mine, which has produced over 1,000,000 ounces of gold, is the largest property in operation. A number of large mines are being developed in the Cue and Day Dawn districts. In the immediate future the Murchison promises to become one of the largest mining fields in Australia.

East Murchison.—This field was opened in 1895 and has an area of 25,420 square miles. Up to date it has produced $16,000,000 worth of

gold. Granites are the prevailing rocks, and these have been greatly intruded by mineralized dikes. Lawler's, Lake Darlot, and Mount Sir Samuel are its most active mining centers.

Mount Margaret.—A large tract of country east of the East Murchison gold field consisting of 45,000 square miles was proclaimed the Mount Margaret gold field in 1897. Most of this field is covered by detrital accumulations which hide much of its mineral wealth and render prospecting difficult, but in many places the detrital formations are auriferous. The most common ore-bearing rocks here, as in so many of the other fields, are granite, gneiss, diabase, and pyroxenite. Mining is chiefly confined to the gold veins occurring in a series of schists similar to those successfully mined westward in the Murchison field. Large auriferous quartzite lodes are frequently met with on this field. The quartz-veins are chiefly of the lenticular type so common in West Australia. The veins occurring along the junction of the diorite and diabase formations with the Archæan rocks are often of great richness. The most famous mine on this field is the Westralia Mount Morgans, at Mount Morgan. The Sons of Gwalia, in the Mount Margaret district, and the Ida H. and Lancefield, at Laverton, are also large producers. Erlistoun, Laverton, Mt. Margaret, Mt. Malcolm, and Leonora, are important mining centers.



LAKE VIEW CONSOLS, KALGOORLIE.

North Coolgardie.—The North Coolgardie gold field, also known as the Menzies field, consists of an area of 30,609 square miles proclaimed for gold-mining purposes in 1897. Originally it formed an outlying part of the Coolgardie field with which it is geologically associated. The principal veins conform to the lenticular type, but irregu-

lar segregation veins are numerous. Some of the richest gold ores have been obtained from the peculiar segregation veins known as the "Coolgardie type," which are either pipes or irregular lenses whose axes follow the cleavage planes of the country rocks. In the oxidized zones the veins are exceedingly rich, but as they are sunk upon they diminish in gold contents. The Queensland Menzies, Lady Shenton, Crusoe Gold Mines, Menzies Mining and Exploration Companies, all English corporations, are largely interested in developing mining properties on this field. In the past twelve years over 1,300,000 ounces of gold have been won from the North Coolgardie mines. Menzies, Malline, Niagara, and Gooncarrie are its most active mining centers.

Coolgardie.—Few mining districts have such a romantic history as Coolgardie. The leading mining center, Coolgardie, from which the field derives its name, lies about 270 miles due east of Perth in the center of a tract of country, which was for many years traversed by explorers on their trips overland to South Australia and elsewhere. Lefroy in 1863, Hunt in 1864 and 1866, Forrest in 1871, and Giles in 1875 all traversed portions of Coolgardie without recognizing its immense mineral wealth. This remained to be discovered by two prospectors who strayed there by chance in August 1892.

In April 1892, Messrs. Bayley and Ford, two prospectors on the Murchison, after selling the alluvial gold they had won on that field, decided to invest the proceeds in prospecting the interior districts eastward. They outfitted at Perth and after numerous adventures approached the Marring field, which was discovered several months previously by Speakman. They met several parties of prospectors returning from the field, however, who reported it to be of no great promise. Bayley and Ford then returned to Southern Cross to refit for a more extensive trip eastwards. They then set out on the old track of the explorer Hunt. When in the vicinity of the native well called Coolgardie they were compelled to return to the Gnarlbine wells for water. They again set out and struck the Coolgardie well where good grass was found. As the explorers reported the land eastwards very dry with long stretches of Spinnifex and sand, they decided to rest and feed their horses well for a few days. While doing so they prospected the water channels around the well. In a few days they collected 200 ounces of gold. Then they sought its source and within a day discovered a vein carrying very rich gold. In a couple of days they broke 500 ounces from the outcrops, located a prospecting claim, and returned to Southern Cross to record their claim and publish their discovery. This news started a wild stampede of miners from every part of Australasia. In the next few years English capital was at-

tracted to the field, and hundreds of prospectors went farther out into adjacent districts and made fresh gold discoveries, and still continue doing so. This has resulted in bringing West Australia to its present eminence as one of the most important gold producers in the world.

The Coolgardie field was proclaimed in 1894 and has an area of 11,974 square miles. Many of the rich veins belong to the type known as gash veins. In 1907 the Coolgardie mines produced 60,810 ounces of gold valued at $1,216,200. The total production of the field to the end of 1907 was 1,197,353 ounces valued at $23,947,040. In the past few years there has been a slight decline in the annual gold yield, due to the fact that capitalists are turning their attention to the alluring prospects of newer fields and are not giving much attention to the development of new mines on the Coolgardie field. This field, however, is highly mineralized and must soon become a great producer.

East Coolgardie.—Ranking next to Broad Arrow as one of the smallest gold fields in the State, East Coolgardie contains some of the richest gold mines in the world. Its famous Kalgoorlie district contains in its remarkable "Golden Mile" the richest belt of gold-bearing formation hitherto discovered. The area of the field, which was proclaimed Sept. 21, 1894, is only 632 square miles.

The largest portion of this field is covered with a deposit of reddish loam and other detrital matter which hides the country rock. The exposed rock formations are chiefly amphibolites, recent eruptives, and sedimentary rocks.

The great mines at Kalgoorlie are operating lodes consisting of a series of banded schistose formations derived from the alteration of amphibolites by dynamic and hydrothermal metamorphism. The lodes belong to the lenticular type. Some of them are half a mile in length and as much as 80 feet in width. They have been developed to a depth of 2,000 feet and at that depth still carry rich gold. This is one of the few fields yielding rich gold tellurides. In the past twelve years East Coolgardie mines have yielded the magnificent total of 9,660,638 ounces of gold valued at $20,000,000.

Conclusion.

Space will not permit of reference to the remaining gold fields or a fuller discussion of those already referred to. Sufficient, however, has been said to indicate the marvellous mineral wealth of West Australia. The wonderful returns already yielded on the comparatively small amount of capital invested in its mining industries, and the remarkable results obtained over practically the whole of its area, assure the future supremacy of West Australia in gold production.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTING.

By C. E. Knoeppel

II. THE IMPORTANCE OF CORRECT BURDEN APPORTIONMENT.

Mr. Knoeppel's series began in the issue of THE ENGINEERING MAGAZINE for October. His discussion next month will take up the elements entering into production costs. An outline of the scope of the entire scheme was given on pages 96 and 97 of our preceding number.—THE EDITORS.

IN the foundry business, as in almost every other branch of endeavor, the margin between success and failure is indeed narrow, often so narrow as to make the foundryman feel like giving up what seems to be an up-hill struggle. In many cases, however, when the fight is hottest and the odds most discouraging, additional information directed along proper channels would assist materially in turning a possible defeat into a victory. That knowledge, however, is the fundamental requirement in inaugurating a campaign of betterment, will be apparent when one considers that the successful man of today is he who acts with force and dispatch; whose action is guided and directed by experience; whose experience is the outcome of this knowledge of the results taking place all round him, secured through the instrumentality of a carefully worked plan whereby pertinent information is automatically and promptly recorded.

Action, then, without which no concern can ever hope to measure up to the limit of its possibilities, is directly traceable to a full knowledge of the important details, perhaps of no real consequence when considered by themselves, but in the aggregate or when compared with other details of like nature, assuming a position of significance. To put it another way, we might state that the results of action vary directly in proportion as *knowledge* increases or decreases, and that knowledge in its turn, is proportionate to the *dispatch* with which results are made known.

Have you ever stopped to consider what is really involved in finding your costs of production, or appreciated the true significance of the word "costing"? If you are keeping costs as a means—cost reduction and increased production being the end in view—then you are (or should be) getting results. If, however, you look upon the

work as a "fad" or necessary evil, using the information at your disposal to no real purpose, you are losing the earning power of money which might be expended to advantage in other directions, and the only consistent advice is either to throw it out altogether, or begin all over again with the determination to make your methods count for something as a result producer.

We are told that "art" is *doing*, while "science" is *knowing;* and on the assumption that this statement is correct, we can only conclude that costing as an art cannot and does not accomplish what is possible if treated as a science, which (to put it another way) is "organized knowledge" and as such must and does get down to the principles involved. The term "costing", considered in the abstract, falls far short of conveying the full meaning, and here is perhaps the reason why so many fail to appreciate its dormant possibilities. To clothe it in its proper aspect let us define it as—

> A science, which has for its purpose to give to the executive an organized knowledge of all pertinent details, that he may be in a position to plan for maximum efficiency. It demands first of all a search for the underlying or basic principles which affect the success or failure of the enterprise, in order to get at the *why* or reason of things. This once established, facilitates the consideration as to *how* things should be done—the *product* or result being proportionate to the excellence of the art or *doing*, upon which depends the *application* and practical use of this product to specific ends.

A great deal has been said, comparing the foundry business with other lines, concerning the simplicity of foundry costing and the ease with which production costs can be determined. Without much consideration this might seem to be the case, especially if we consider foundry costing as an "art," the doing; but considered as a science, it is far from being the case. Put these same men, who scoff at the idea of foundry costing being anything else than a simple process, right in the midst of the fight—as foundry managers with instructions to secure a maximum production at the greatest margin of profit—and it will be only a matter of time when their views will undergo a pronounced change. Inasmuch, however, as any particular science is nothing but organized knowledge in one special field, why is it not possible to make our foundry costing more scientific and in this way perhaps more simple?

Getting back to our definition, we find that we must search for the basic elements that we may start right and at the beginning, for

once we build a solid foundation, we can start the construction with the expectation of erecting a permanent structure. In the first place every foundryman will agree with the statement that a business is conducted for profit, and that while it is one thing to dispose of something, it is quite another to dispose of it at a margin over and above total cost, knowing that you have made it and how much. Here we have two elements:—

Disposing at a profit.

Disposing at a loss.

Naturally, if you have the interests of your business at heart, you will want to know:—

Where you have made or lost.

How much you have made or lost.

Why you have made or lost.

How do you know but that you may be losing money on some lines of work, bringing your net profits down to a figure that might have been increased had you known where the losses were, the amounts, and the why? Why is it important to know where and why you have made? Simply because nothing is so good but that it can be bettered by persistent effort; and if you have made something on one line of work, keep after it—better the conditions and make more money.

The basis of the sale is what is produced, which as far as this series of articles is concerned will be *castings*. Therefore to find the true condition of affairs, we must determine what the profits or losses are, which cannot be done until *costs* are ascertained. It has long been taken for granted that costs could not be determined until the completion of the work, but the foundryman should have some means of knowing about what the costs are going to be *before the work is even started*. The importance of this will no doubt appeal to every foundryman, and this point will be considered by this series of papers.

The next consideration is the elements entering into the cost of producing good castings, which can be divided into three general classes:—

1.—Materials { Direct or productive—A. / Indirect or non-productive—B.

2.—Labor { Direct or productive—A. / Indirect or non-productive—B.

3.—General Expenses.

No argument is necessary to show that if the three elements with their subdivisions could be charged to the production direct, the de-

termination of costs would be a simple matter; but a glance at the table just shown will convince the reader that direct charging is possible in two cases only:—

Direct material—1A.

Direct labor—2A.

and this fact makes it necessary for the production to absorb the other three items in some just and equitable manner to be decided upon, the sum of these three items being, in the majority of cases, a large one; so that upon the correctness with which these items are spread over or apportioned to the production, depends more than is usually conceded. We can therefore safely say, in our search for principles, that the matter of properly handling these three items is of the utmost importance and can be really classed as our basis or foundation.

Direct or productive materials comprise the various pig irons, scraps, fluxes, coke or coal, the total cost for any period being a *direct* charge against whatever is produced.

Indirect or non-productive materials comprise incidental stores, supplies, etc., which are used in order to facilitate the manufacture of the product; the total cost for any period, although a charge against what is produced, cannot be charged direct but must be apportioned to it.

Direct or productive labor is the money paid to those who actually produce or directly assist in producing something having a *commercial value*, which can at all times be charged direct to specific production.

Indirect or non-productive labor is the money paid to those who, while they do not actually produce or assist in producing anything of value, are absolutely necessary in order that production may be facilitated and carried on to the best of advantage; this expenditure constitutes a charge to production by apportionment, owing to the difficulty in attempting to charge to product direct.

Expense is the expenditure entering into the general administration of the business, the securing of a finished product as well as the marketing of this product to the best of advantage, which on account of its very nature cannot be charged to production direct but must be absorbed by it by apportionment.

In this series of articles, the three items—

Indirect materials.

Indirect labor.

Expenses

will be classed as "burden"—aptly styled by one as "unseen dollars"; and as was before stated, the amount of this burden is usually a large one, so that apportionment must be as correct as possible, otherwise total costs are bound to be misleading. We can get at this matter of apportionment easier by looking at it as if a month's production consisted of *one* casting, in which case the entire burden would be charged direct to it. If the production consisted of ten castings, however, each weighing the same, with the material and labor costs the same for each of the ten castings, then each would absorb one-tenth of the burden; and when the cost of the last casting was ascertained, it would be found that the entire burden had been absorbed in a just and equitable manner. If, on the other hand, we substitute, as the production, one-thousand castings of different shapes and weights with absolutely no relation existing between the cost of the direct labor or direct material, how are we going to make these castings absorb the expense item so that each casting or class of castings will be charged with an equitable amount?

If one-thousand tons of good castings are produced in a certain period and the total burden for the same period is $10,000, we can make the production absorb this burden by charging $10 to each ton of castings produced—this being one method which we will term *tonnage apportionment.*

If on the other hand, one-thousand tons of castings are produced in a certain period and the direct-labor cost of producing these castings is $5,000 with a burden against this production of $10,000, we can make this production absorb this burden by adding 200 per cent to the direct-labor cost of any casting or class of castings, or $2 in expense for every $1 in direct labor—another method which we will term *direct-labor apportionment.*

It stands to reason that both methods cannot be right, although each seems to have its defenders. If one method is correct, then there is some reason *why* it is right and the other wrong, and this "why" must appeal to you, from a *dollar and cent* point of view. To show it all up in a way that will be clearly understood, it has been deemed advisable to submit several cases, showing the difference between the two methods; and while at best figures are dry and uninteresting, a quiet hour, plus a careful study of the figures which are to follow, will make the deductions surprisingly interesting.

We will suppose that in a certain period of time, your foundry produced 2,500,000 pounds of salable castings, your direct or productive pay roll (moulders and coremakers) being $15,000; the

burden amounting to $22,500, and your rates for apportionment, in order to make the 2,500,000 pounds absorb the $22,500, being:

Tonnage basis—90 cents per 100 pounds.

Direct-labor basis—150 per cent.

Case No. 1—Light and Heavy Work. Different Weight—Same Labor.

You make two castings, in this period, one being a small complicated affair, weighing 250 pounds, which we will call a gas-engine cylinder; the other being a small flywheel weighing 2,000 pounds, each on account of its nature requiring the entire time of a moulder for a day. Figuring material at $1 a hundred pounds for melted iron and labor at $3 per day (30 cents per hour), we have costs as follows:—

	250 lb.			2000 lb.	
Tonnage Basis.	$2.50		....Material	$20.00	
	3.00		....Labor (10 hours).....	3.00	
	$5.50		....Prime cost	$23.00	
	2.25		....Burden (90c. per 100 lb.).	18.00	
		$7.75 (A)	....Total cost		$41.00 (C)
Labor Basis.	$5.50		....Prime cost	$23.00	
	4.50		....Burden @ 150 per cent...	4.50	
		$10.00 (B)	....Total cost		27.50 (D)
		$2.25	....Difference		$13.50

Cost A is	$3.10	per	100	lb.	Cost C is	$2.05	per	100 lb.
" B "	4.00	"	"	"	" D "	1.37½	"	" "
Difference	.90	"	"	"	Difference	.67½	"	" "

A study of these figures will show that in the case of the 250-pound casting, the cost B is $2.25 *higher* than cost A, while in the case of the 2,000-pound casting, cost D is $13.50 *lower* than cost C. Looking further, it will be found that cost A is $3.10 per 100 pounds, while cost B is $4 per 100 pounds, the cost B being greater than cost A by 90 cents per 100 pounds, *only* a difference of $18 per ton. Cost C figures out at $2.05 per 100 pounds with cost D at $1.37½ per 100 pounds, the latter being less than the former by 67½ cents per 100 pounds, or $13.50 per ton. As the intention of this article is to show that the tonnage basis of burden apportionment is incorrect, this can best be proven by showing that direct-labor apportionment is correct. In the first place, we have a small casting weighing only 250 pounds and taking the entire time of a moulder for the day, while a

casting eight times as heavy was produced in the same length of time so that the ***productivity*** (relative amount produced per man per day) of the latter is eight times greater for the particular case than that of the former. If, for the sake of argument, we assume that the tonnage basis is correct, giving the preceding statement the consideration it is entitled to, we find that the tonnage basis as compared with the labor basis forces the costs per 100 pounds to *decrease* as productivity *decreases* and to *increase* as productivity *increases*. Does this strike you as being logical? On the other hand, we find comparing labor apportionment against tonnage apportionment, that the former forces costs to *increase* as productivity *decreases* and to *decrease* as productivity *increases*, which is as should be. Looking again at case No. 1, it will be found that in cost B, the burden of $4.50 is really $1.80 per 100 pounds instead of a flat rate of 90 cents per 100 pounds, and in cost D, the burden is 22½ cents per 100 pounds instead of the 90-cent rate. In this way you are making the light, complicated cylinder cost the most per 100 pounds to produce ($4 instead of $3.10), and the heavier but easier to make wheel cost considerably less per 100 pounds ($1.37½ instead of $2.05)—which are things which the tonnage basis of apportionment ignores altogether. Putting it still another way, would you rather accept cost C as the correct cost, add 10 per cent as profit, and run the risk of losing the order through what is in reality an overestimation of $13.50 per ton; or take cost D as your basis, add your profit, which with other things being equal would land the order? On the other hand, would you rather take $4 per 100 pounds as your cost for the 250-pound casting, which in making cost you $1.20 per 100 pounds, add your profit and *make it*, or use $3.10 per 100 pounds as the cost—90 cents per 100 pounds less—add your profit, and get the work—but lose money on it?

Case No. 2—Heavy Work.
Same weight—Different labor.

In this case I assume that in your foundry you have made two castings, each weighing 10,000 pounds, one taking 60 hours to make, while the other was made in 20 hours. As the productivity of the man who made the one piece in two days is greater than that of the man who made the other piece in six days, it is logical to expect that the piece which took the least time to make—where the productivity was greatest—would cost much less than the piece taking the larger amount of time with a smaller productivity.

Let us see, however, how it works out, placing the six-day and ten-day jobs in parallel columns:

	10,000 lb.				10,000 lb.	
Tonnage Basis.	$100.00		..Material	$100.00		
	18.00	(60 hrs.)	..Labor	6.00	(20 hrs.)	
	$118.00		..Prime cost	$106.00		
	90.00		..Burden (90c. per 100 lb.)	90.00		
		$208.00 (A)	..Total cost		$196.00 (C)	
Labor Basis.	$118.00		..Prime cost	$106.00		
	27.00		..Burden @ 150 per cent.	9.00		
		145.00 (B)	..Total cost		115.00 (D)	
		$63.00	..Difference		$81.00	

Cost A is $2.08 per 100 lb. — Cost C is $1.96 per 100 lb.
" B " 1.45 " " " — " D " 1.15 " " "
Difference .63 " " " — Difference .81 " " "

A study of these figures will show, in the first place, that cost B is less than cost A by $63, while in the case of the casting where the elements are greater productivity and lower labor cost per 100 pounds, cost D is $81 less than cost C, a net decrease of $18. Also that cost C is less than cost A by $12, while cost D is less than cost B by $30. Looking at it still another way, we find that cost A is $2.08 per 100 pounds while cost B is $1.45 per 100 pounds, a difference of 63 cents per 100 pounds or $12.60 per ton. Cost C is $1.96 per 100 pounds with cost D $1.15 per 100 pounds, a difference of 81 cents per 100 pounds or $16.20 per ton, showing that the decrease is greater in the latter case, *as it should be.* By this method we are making the casting in which the elements are high moulding cost and low productivity, cost the most; and instead of charging a flat rate of 90 cents per 100 pounds, we make cost D bear 9 cents per 100 pounds and cost B 27 cents per 100 pounds—the increase being a logical one, as reflection will show, yet both rates are much less than the 90-cent rate. It should be plain that if costs A and C are used as a basis, they are overestimated to the tune of 63 cents and 81 cents per 100 pounds respectively—large enough to make any foundryman "sit up and take notice" inasmuch as there cannot be an *everestimation* in one place without *underestimation* in another, neither of which elements should be allowed to creep into any business. The advantages of using costs B and D in bidding for heavy work, instead of the prohibitive figures shown in costs A and C, are no doubt apparent without any explanation.

Case No. 3—Light Work.
Same weight—Different labor.

In this case we have two small castings, each weighing 150 pounds, one taking 7 hours to make, the other 3½ hours—low productivity in both cases, one being even lower than the other. As direct-labor apportionment makes costs increase over tonnage apportionment as productivity decreases, we naturally expect to find that costs under the former will be higher than under the latter, which the following figures will show to be the case:—

	150 lb.			150 lb.	
Tonnage Basis.	$1.50		Material	$1.50	
	2.10	(7 hrs.)	Labor	1.05	(3½ hrs.)
	$3.60		Prime cost	$2.55	
	1.35		Burden (90c. per 100 lb.)	1.35	
		$4.95 (A)	Total cost		$3.90 (C)
Labor Basis.	$3.60		Prime cost	$2.55	
	3.15		Burden @ 150 per cent.	1.58	
		6.75 (B)	Total cost		4.13 (D)
		$1.80	Difference		.23

Cost A is $3.30 per 100 lb. Cost C is $2.60 per 100 lb.
" B " 4.50 " " " Cost D " 2.80 " " "
Difference $1.20 " " " Difference .20 " " "

From this case, it will be seen that through the labor basis of apportionment cost B is $1.80 greater than cost A, while cost D is 23 cents higher than cost C. Comparing A with C, we find the former greater by $1.05, while B is $2.62 greater than D. Consideration will show that once more we get our greatest increases where they should be, costs B and D being greater than A and C by $24 and $4 per ton respectively. In this case instead of using a flat rate of 90 cents per 100 pounds, we have the burden $3.15, amounting to $2.10 per 100 pounds and the item of $1.58 amounting to $1.06 per 100 pounds.

Comparing all of the three cases, we find that in every case the burden cost on the tonnage basis was 90 cents per 100 pounds, while on the six castings of the three cases cited, we get rates, in cost per 100 pounds, on the direct-labor basis, as follows:—

$1.80 per 100 lb.
.22½ per 100 lb.
.27 per 100 lb.
.09 per 100 lb.
2.10 per 100 lb.
1.06 per 100 lb.

We find that the lowest rate is 9 cents per 100 pounds (cost D, case No. 2). Here we have an hourly product of 500 pounds—*high* productivity, and a labor rate of but 6 cents per 100 pounds, consequently the cost should be low and reference will show that through direct-labor apportionment, the cost was $115 instead of $196. Is not the low rate of 9 cents instead of 90 cents justified, when the facts in the case are considered? We also find that the highest rate is $2.10 per 100 pounds (cost B, case No. 3). Here we have an hourly product of about 21½ pounds instead of 500 pounds—*low* productivity, and a labor rate of $1.40 per 100 pounds instead of 6 cents per 100 pounds; consequently to take care of yourself properly, you must have a higher cost than tonnage apportionment would give you, for by means of it you get a cost of $3.30 per 100 pounds, while through direct-labor apportionment your cost is $4.50 per 100 pounds.

The only logical conclusion from the figures heretofore shown is, first, that through the tonnage method of apportionment, the cost of heavy work is made too high; and second, that the cost of light work is made too low. We also get a rule from direct-labor apportionment, that *burden costs are inversely proportional to productivity*, which the tonnage basis does not recognize. Now then, as the tendency in commerce is to lose in bulk of sales as price increases, it should be evident to every foundryman, that making the cost of heavy work too high is sure to result in lost sales in the case of the jobbing foundry, or an excessive cost of the foundry production to the machine shop in the case of the specialty foundry. On the other hand, by making the cost of light work too low the tendency is to get plenty of light work at prices which are in reality less than cost. The result is that both jobbing and specialty foundries are hurt alike.

Getting back to productivity, we may state the fact that the more a man produces in a given time, the less should be the cost of what he produces, and *vice versa*. If, then, the tonnage basis of apportionment as against the labor basis does not take this fact into consideration (and the figures heretofore shown clearly indicate that it does not) then the method has absolutely no merit and is consequently worthless from a commercial standpoint. To demonstrate its inaccuracy clearly, it was decided to show the difference between the two methods graphically.

Chart 1 shows amounts produced per man per day, from 200 pounds to 2,000 pounds, at different costs per 100 pounds, line 1 showing burden apportioned to direct labor and line 2 showing burden apportioned to tonnage. In plotting this chart, the rates heretofore

mentioned were used, namely 90 cents per 100 pounds on tonnage, 150 per cent on the direct labor, and a daily labor rate of $3, so in order to arrive at our values for line 1, we take $4.50 as the burden, which is divisible by whatever weight is produced per man per day. A glance at the chart will show that there is a vast difference between costs of $18 and $22.50 per ton, on a production of 400 pounds for a man in a day on the one hand, and $18 and $4.50 per ton, if the same man can produce 2,000 pounds in a day, on the other.

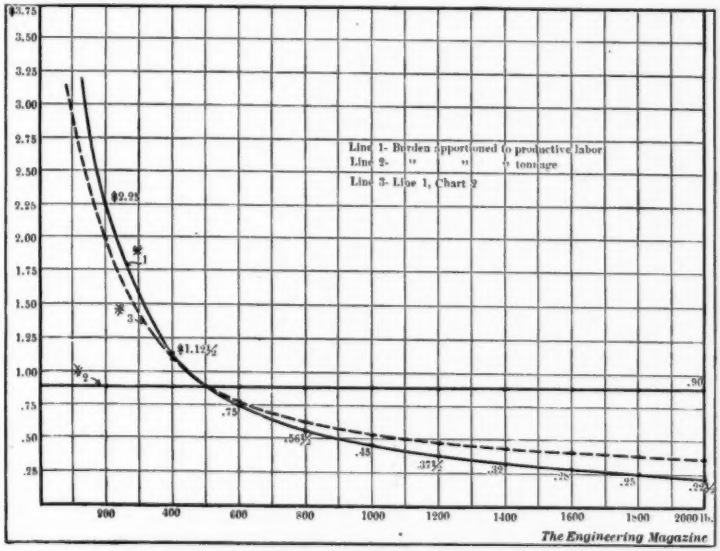


CHART I. BURDEN COSTS PER 100 POUNDS FOR DIFFERENT WEIGHTS PRODUCED PER MAN PER DAY.

A foundryman is likely to bring up the point, at this time, that certain items of expense are proportionate to the increase or decrease of the amount produced which a uniform basis of labor apportionment would fail to consider. That such a point would be well taken can be seen when it is considered that in a large number of cases, the more a foundry is able to produce, the greater would be such items as foundry, core-room and cupola supplies, cupola labor, repairs to flasks, yard labor, handling materials, and perhaps a few other items. A compromise, then, which will enable tonnage to absorb a certain proportion of the burden, and productive labor the balance, is perfectly logical—the result of such a combination method being shown by Chart 2, the same expense item being used as in the case of Chart 1.

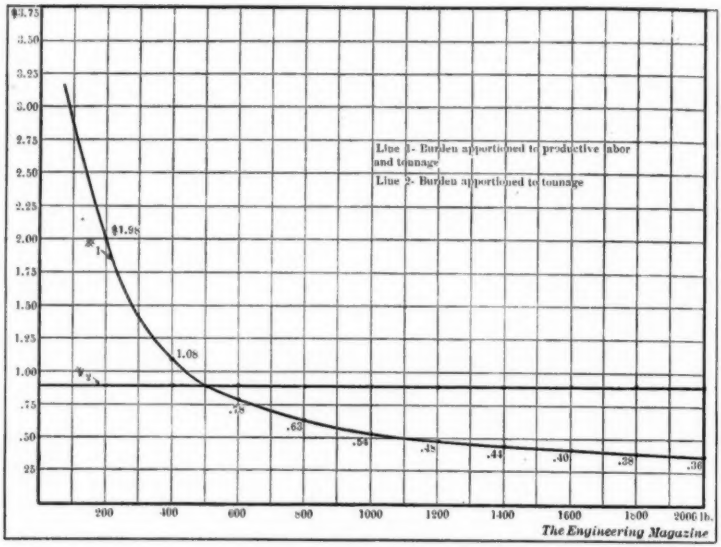


CHART 2. BURDEN COSTS PER 100 POUNDS FOR DIFFERENT WEIGHTS PRODUCED PER MAN PER DAY.

with the exception that we assume that $4,500 of the $22,500 is proportionate to tonnage, the balance to direct labor, the rates being:

Line 1—Compromise basis } 18 cents per 100 pounds on tonnage
120 per cent on direct labor.

Line 2—Flat tonnage basis—90 cents per 100 pounds.

To show the comparisons properly, line 1, Chart 2 has been carried to Chart 1 as line 3, the following illustration serving to show the difference between burden apportionment—one case being a large production per man per day and the other a small production. Taking the case of large production per man per day first, we have:

CASE NO. 4.

	Tonnage Basis.		Labor Basis. 2000 lb. Casting.		Tonnage and Labor.	
Material	$20.00		$20.00		$20.00	
Labor (10 hrs.)	3.00		3.00		3.00	
Prime cost...	$23.00		$23.00		$23.00	
Burden	18.00	(90c. per 100 lb.)	4.50	(150%)	3.60	(18c. per 100 lb.)
					3.60	(120 per cent)
Total	$41.00		$27.50		$30.20	
Per 100 lb...	2.05		1.37½		1.51	

Examining now the figures with small production per man per day, we find:

			400 lb. Casting.			
Material	$4.00		$4.00		$4.00	
Labor (10 hrs.)	3.00		3.00		3.00	
Prime cost ..	$7.00		$7.00		$7.00	
Burden	3.60	(90c. per 100 lb.)	4.50	(150%)	.72	(18c. per 100 lb.)
			....		3.60	(120%)
Total	$10.60		$11.50		$11.32	
Per 100 lb...	2.65		2.87½		2.83	

After considering all that has gone before, Chart 3 will no doubt prove of particular interest to foundrymen, in that it shows *total costs* for different weights produced per man per day by the various methods of apportionment. Moulding cost has been taken at $3 per day of 10 hours, with material at $1 per 100 pounds of melted iron, burden on the tonnage basis being 90 cents per 100 pounds, on the direct-labor basis 150 per cent, and on the tonnage and labor basis, 18 cents per 100 pounds on tonnage and 120 per cent on labor—these rates being the same as used in previous illustrations. The labor of making cores is not included in the figures, as for the purpose of illustration it was deemed advisable to consider simply the work of moulding, which would include the work of setting the cores, making it an easy

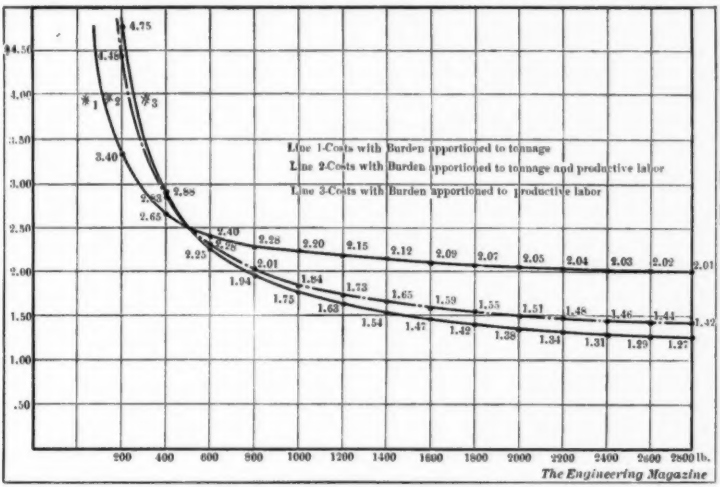


CHART 3. TOTAL COSTS (MATERIAL, PRODUCTIVE LABOR, AND BURDEN) FOR DIFFERENT WEIGHTS PRODUCED PER MAN PER DAY.

matter, in using charts of this nature, to add the core labor to any of the total costs.

The conclusions that can be arrived at from a study of these charts are, first, that *the various methods are correct at the point where the lines cross;* but that to the right of the intersection, the burden and total costs, per 100 pounds, on the direct-labor or direct-labor and tonnage methods of apportionment, decrease as the amount per man per day increases; while to the left of the intersection, the costs increase as the product per man per day decreases, while it will be seen that from Charts 1 and 2, the burden costs on the tonnage basis are the same *regardless* of whether 200 pounds or 2,000 pounds are produced per man per day; this explains the slight increase and decrease of the cost as shown by line 1, Chart 3. The direct-labor or the compromise method considers that the direct labor is in a sense the *real investment* on which success or failure depends, for the reason that, as a rule, the more producers there are at work, the greater will be the production and the lower the costs, while costs increase and production decreases as the number of producers decrease. Consideration is given to the great variety of work in a foundry, making the costs of both light and heavy work about what they should be, instead of too low in one case and too high in the other.

The value of Chart 3, to those who desire to know instead of guess, will be apparent after due consideration, and as it is possible to plot such a chart from the records of any foundry, the rules given in Chart 4 may be found of interest as well as of assistance in determining the values for charting. With figures from your own records, substituted for the values shown in 3, you will be surprised, at the margin of difference between the three methods. The costs of good castings at 2,200 pounds per man per day, from 3, are shown as $2.04, $1.48, and $1.34 per 100 pounds, while at 200 pounds the costs are $3.40, $4.48, and $4.75 per 100 pounds, while further all three lines cross at $2.50 per 100 pounds for 500 pounds per day per man. *What does the chart covering your own work show you?* From 3, or from your own chart, it is evident that all three methods cannot be right; and as the inaccuracy of the tonnage method of apportionment has been demonstrated, it leaves only two others to choose from. Eliminating from our burden those items which are more proportionate to the increase or decrease in the production, we have left those items which are proportionate to direct labor; so that we have by this process also demonstrated that direct-labor apportionment is incorrect, although it would be far better to use this method than ton-

nage apportionment—leaving only one method, *apportionment to tonnage and direct labor.*

TONNAGE BASIS.

$$\frac{\text{Expenses}}{\text{Weight of Castings Produced}} = \text{Rate per 100 lb.}$$

DIRECT LABOR BASIS.

$$\frac{\text{Expenses}}{\text{Productive Payroll}} = \text{Rate in Per Cent.}$$

TONNAGE AND DIRECT LABOR BASIS.

$$\frac{\text{Expenses Proportionate to Tonnage}}{\text{Weight of Castings Produced}} = \text{Rate per 100 lb.}$$

$$\frac{\text{Expenses Proportionate to Direct Labor}}{\text{Productive Payroll}} = \text{Rate in Per Cent.}$$

RULES FOR APPORTIONING BURDEN AT THE RATES ABOVE.

W = Weight produced per man per day.
M = Metal cost.
L = Amount paid to moulder per day.
B_1 = Burden on tonnage.
B_2 = Burden on direct labor.
B_3 = Burden on tonnage (A) and direct labor (B).
C_1 = Cost per 100 lb. on tonnage apportionment.
C_2 = Cost per 100 lb. on direct labor apportionment.
C_3 = Cost per 100 lb. on tonnage and direct labor apportionment.

TONNAGE BASIS.

$$\frac{(W \times M) + L + (W \times B_1)}{W} = C_1.$$

DIRECT LABOR BASIS.

$$\frac{(W \times M) + L + (L \times B_2)}{W} = C_2.$$

TONNAGE AND DIRECT LABOR BASIS.

$$\frac{(W \times M) + L + (W \times B_3A) + (L \times B_3B)}{W} = C_3.$$

CHART 4. RULES FOR ARRIVING AT BURDEN RATES.

As the purpose of this article was to start our foundation before commencing the structure, we can with safety decide on this latter method as being the basic element about which a system of foundry costing can be created; and with the matter of burden *apportionment* disposed of, knowing that we are right in principle, we can take up the elements entering into burden *construction,* which will be the purpose of the paper to follow.

RECENT DEVELOPMENTS IN MOTOR VEHICLES FOR INDUSTRIAL PURPOSES.

By Harry Wilkin Perry.

In a series of two articles, of which this is the first, Mr. Perry summarizes the most interesting features of recent progress in adapting the motor vehicle to industrial purposes. This first section deals chiefly with mechanical improvements and with wagons for ordinary transportation. The following portion is concerned more particularly with applications to quasi-public service, and vehicles for various specialized uses.—THE EDITORS.

THERE has been a marked awakening of interest of late in the self-propelled vehicle for industrial purposes, and it is thought by those best qualified to judge that in the near future the production of such vehicles will outrank in importance the manufacture of pleasure automobiles. The commercial motor vehicle had its beginning in America about ten years ago, almost simultaneously with the advent of the light steam runabouts and surreys which had a great vogue; but its development was retarded by the concentration of effort upon the pleasure car, which appealed more to popular interest and realized more prompt and liberal returns to experimenter and builder. Now that the touring car and runabout have been brought to approximate standardization, much more of the attention of engineers and constructors has been devoted to the motor truck and delivery wagon during the last two or three years.

Although steam vehicles predominated in America eight years ago, the steam delivery wagon and steam wagonette for public stage lines are practically non-existant and steam machines are no longer a factor in the situation, with the exception of a very few steam ambulances and patrol wagons. Heavy steam trucks, such as are common in England, have never met with success on the western side of the Atlantic, and are built now only in an experimental way or to special order.

The day of the steam vehicle was succeeded by a period of considerable activity in the manufacture of electric delivery wagons and heavy trucks. Hundreds of these were bought by retail merchants, brewers, telephone and electric-light companies, and others having much heavy hauling to do. America quickly took the lead of all

nations in the manufacture and use of electric vehicles, both for business and pleasure purposes, and she still holds this premier position. In the meantime, however, great progress has been made in studying out the problem of the so-called gasoline or internal-combustion-engine vehicle, both in Europe and at home, and there can be little doubt that this type is fast taking the lead both in number and importance. Obvious reasons why it should do so are the economy of burning the fuel inside the engine cylinders, thereby utilizing the maximum of heat units, the lighter weight of vehicle in proportion to load carried than with the great majority of electric vehicles, and the ability to travel indefinitely over ordinary country roads so long as gasoline—and in some cases kerosene—is available.

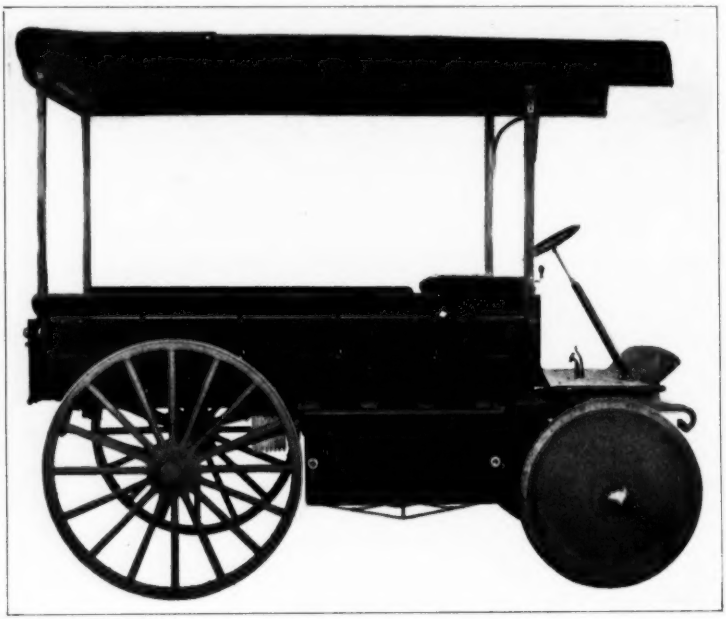
Vehicles for Private Commercial Work.

Although many of the earliest electric trucks and delivery wagons are still in service, many improvements have been made since they were built. Notable tendencies during the last year or two have been in the direction of decreasing the weight of the vehicle in proportion to its load capacity; increasing its radius of action on one charge of the battery by fitting anti-friction bearings to the wheels and motors, and employing improved batteries having a greater or longer output of power relative to size and weight; prolonging the life of the running gear by suspending the motors from the main frame which is carried on the springs; reducing the noise by driving with side chains instead of gears and enclosing the reducing gears; decreasing wear by better protection of wearing parts and more thorough lubrication. It can be affirmed without prejudice in the light of exhaustive trials that a very marked advance in the electric field is shown by the combination of the Lansden wagon and Edison nickel-iron battery, as now used most extensively, perhaps, by the Adams Express Company, which has supplanted its former horse service in New York, Buffalo, New Haven, Indianapolis, and Washington with electric vehicles and will make similar changes in its service in all the large cities.

Four-Wheel-Drive Electric Trucks.

Because of the flexible transmission of power possessed by the electric vehicle, the advocates of front-wheel drive and four-wheel drive have found concrete expression of their ideas most easy in vehicles utilizing the electric current for propulsion. To the engineer the most interesting development along this line is the couple-gear freight wheel truck which is now made in 1-ton, 3-ton and 5-ton

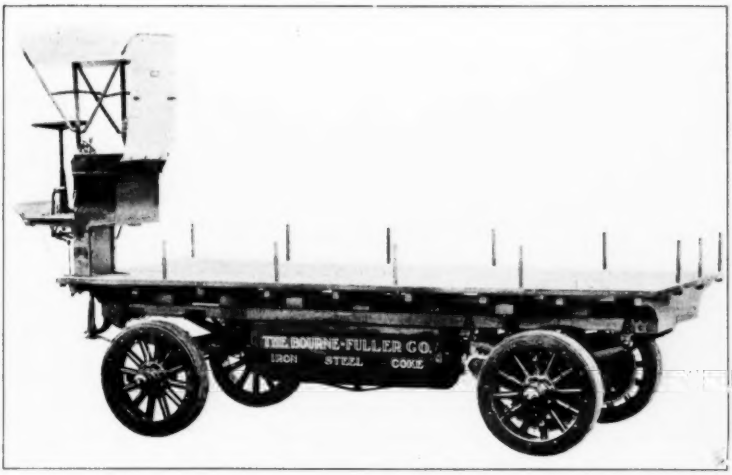
models in Grand Rapids, Mich. The striking feature of these machines is the housing of the electric motors within the wheels, which are formed of two opposed rings having teeth cut in their opposed faces, a steel tire encircling them and two steel discs bolted to their outer faces. The builders claim to have determined by Prony brake test that with this construction 97 per cent of the energy developed by the motor at full load is transmitted to the periphery of the wheel.



COUPLE-GEAR ONE-TON ELECTRIC EXPRESS WAGON WITH FRONT DRIVE.

Speed 9 miles an hour; two 3 horse-power motors concealed in front wheels; battery, 40 cells W. B. plates; wheel base 82 in., tread 53 in.; tires, front 36 by 3 in., solid; rear 48 by 2½ in., steel.

While the larger couple-gear trucks are built with motors in all four wheels, the 1-ton express wagons have motors only in the front wheels, which are also the steering wheels. In one model dummy metal wheels are fitted in the rear, and in another a pair of steel-tired wagon wheels are fixed to the rear axle. This vehicle has a speed of 9 miles an hour, with load, and a radius of action of 40 to 50 miles on one charge of the 40-cell 11-plate battery. The two motors are of 3 horse-power each and can be overloaded momentarily to 200 per cent, or will sustain an overload of 100 per cent for 15 minutes.



STUDEBAKER 5-TON ELECTRIC TRUCK FOR RODS AND ANGLES.

Driver's seat arranged to give unobstructed platform and allow load to project in front. Wood tires, underslung battery box, and double motor drive through side chains.

An electric vehicle excels all other classes in the matter of available load area. This is clearly illustrated in the photograph of the 5-ton Studebaker truck supplied to the Bourne-Fuller Company for hauling iron and steel. The driver's seat is mounted, with all control mechanism and folding top, on a small pedestal at the extreme left front corner of the platform, leaving the platform otherwise unobstructed. Extra long rods and angles can be loaded to project both fore and aft. The battery is underslung, as in practically all new electric business vehicles, and the double motors drive by side chains to the rear wheels. Wood tires are used on this vehicle, as they are on many other heavy trucks built to carry loads of 5 tons or more. They are made of wood blocks set with the grain radial to the hub of the wheel.

New Gasoline Trucks by Leading Automobile Concerns.

While electric vehicles are conceded to have many advantages for use in the city, particularly for short hauls with frequent stops, the truck or wagon that is driven by an internal-combustion motor is best adapted for long hauls over country roads, particularly with loads up to 3 tons. While apparently devoting all of their time and energies to the production of pleasure cars to meet the constantly growing demand, the foremost automobile-building concerns in America have

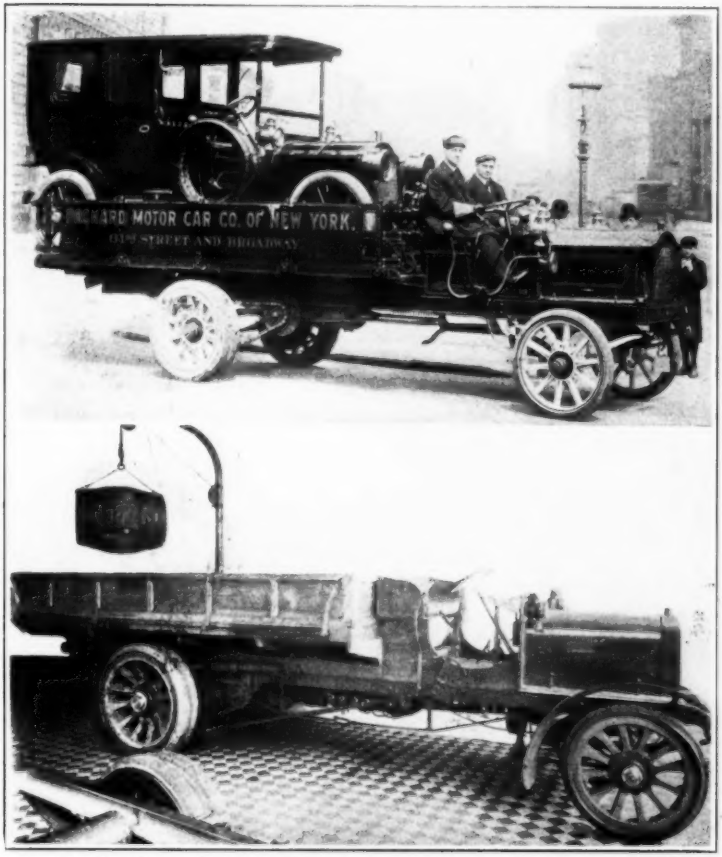
been experimenting quietly with the manufacture and testing of such trucks. Among these may be mentioned the Winton, Packard, Peerless, Pierce and Autocar companies, the American Locomotive Company, Corbin Motor Vehicle Corporation, H. H. Franklin Manufacturing Company, and Matheson Motor Car Company. These makers have been holding back the manufacture of commercial cars until they could privately test their experimental machines sufficiently to feel safe in backing them with their established reputations in the pleasure car field or until market conditions should warrant diverting capital and effort to this branch of the industry.

The Packard company has during the past summer, put through a lot of twenty-five 3-ton gasoline trucks similar to that illustrated in one of the accompanying engravings showing a limousine car on the platform.

The power plant is carried over the front axle under a protecting hood of pressed steel. The driver's seat, as in touring cars and most of the European motor trucks, is back of the dash behind the engine. This brings the center of the "paying load" well over the driving wheels while the front wheels carry the weight of the engine and driver. The engine is of the standard 40 horse power touring-car type, having four vertical cylinders cast in pairs with integral water jackets.

Driving connection between the engine and the running gear is effected by an expanding clutch that operates within the recessed flywheel. The action of this is controlled by a pedal in front of the driver and also by the emergency brake lever. The speed-changing gear set is combined with the differential gearing in a single rigid metal housing on the countershaft or jack shaft which is suspended from the main frame in front of the rear wheels. Final drive is by side chains from sprockets on the ends of the countershaft to large sprocket wheels on the emergency brake drums bolted to the inner side of the drive wheels. Service brakes of the expanding type act within drums on the ends of the countershaft and are operated by a pedal. The hand lever that sets the rear wheel brakes has a notched quadrant for locking the brakes when desired.

In its general features the Packard truck is typical of many of the best makes of European trucks and for this reason it has been described at some length. A close similarity may be noted between it and the new "Commer car lorry" built by Commercial Cars, Ltd., of England, for brewers' work. This lorry has a capacity of 4 tons, and is fitted with a swivel jib crane operated by the engine. This crane has a capacity of 10 hundred-weight (1,120 pounds) at a speed



ABOVE, PACKARD 3-TON GASOLINE TRUCK WITH BODY FOR GENERAL PURPOSES. BELOW, COMMER CAR GASOLINE 4-TON ENGLISH LORRY FOR BREWER'S WORK.

The Packard car weighs 5,000 lb. without body, and has a maximum speed of 12 miles an hour; 40 horse-power four-cylinder vertical engine. The Commer car lorry is fitted with swivel jib crane, hoisting 1,120 lb. at 80 to 120 ft. per minute, and operated by the truck engine.

of 80 to 120 feet per minute. The Commer car "lorry" was one of the notable exhibits at the Second Annual Commercial Motor Car Exhibition held in Olympia Hall, London, March 27 to April 4 last. Special features of construction that will be observed at a glance are the use of truss rods with turnbuckles for giving vertical strength and rigidity to the frame, the use of a heavy external emergency brake rod, massive steering arm and joint, and hinged sides on the

ABOVE, PEERLESS 3-TON GASOLINE TRUCK; BELOW, PIERCE 5-TON EXPERIMENTAL GASOLINE TRUCK.

The Peerless truck was built for private work and tests in actual service. The Pierce truck weighs 7,290 lb. and has an average speed of 15 miles an hour; driven by 50 horse-power four-cylinder vertical engine.

body. The Commer car was designed after the Saurer truck built in Switzerland, with the exception that the change-speed gearing is an English invention and affords four forward speeds; it is of the selective gear pattern, the gears being always in mesh and any pair engaged at will by jaw clutches that slide on squared portions of the primary shaft. The main characteristics of this lorry are so nearly

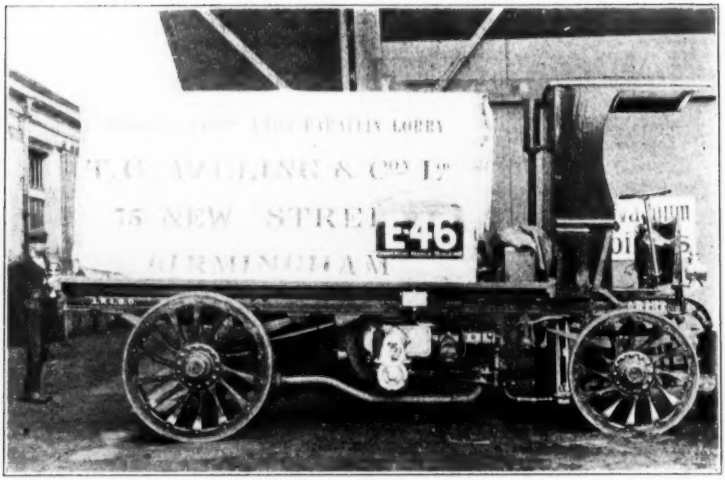
like those of the Packard truck that the student cannot fail to observe how close together are leading constructors in Continental Europe, England, and America in the matter of design for vehicles of this type and capacity, and to surmise that they are fast approaching a standard of construction.

Data from Seven-Months Work by a Truck.

The trucks produced for experimental work by the Pierce and Peerless companies represent a type that is more distinctly American than the Packard, with the driver's seat built directly over the engine space above the front axle, thus shortening the overall length and the wheel base, which facilitates turning in narrow streets, permits of a slightly longer load platform with less overhang at the rear, and brings the center of the load well forward of the rear axle. The steering columns are vertical, or nearly so, and the fuel tanks are in front of the dash above the radiators. The Peerless truck, which has a load capacity of 3 tons, is driven by a four-cylinder 45-horse-power gasoline engine. Side driving chains are eliminated by the use of a driving shaft from the change-speed gear box to differential gearing on the "live" rear axle. The Pierce truck is built for loads of 5 tons and is driven by a 50-horse power four-cylinder engine. With the object of giving it a thorough test in actual service, it was placed in the service of the B. F. Goodrich Co., rubber goods and automobile tire manufacturers of Akron, Ohio, who have kept careful records of the performance and cost of operation and maintenance. Since last November it has hauled all of the product of the company's very large plant from the factory to the railroad station 1.3 miles away, displacing three two-horse teams and wagons that were kept constantly busy and which cost for maintenance, together with drivers' wages, $15 a day. The average daily cost of operating the truck, everything included except tires, has been $9.35. During the first seven months of service the actual cost of replacements of defective or worn parts has averaged $1 a month. An average of 85 tons of goods is hauled daily, single loads ranging from 11,000 to 15,000 pounds; on one occasion the truck carried more than 100 per cent overload—20,960 pounds, to be exact. The average speed is about 15 miles an hour, notwithstanding Akron is both hilly and badly paved.

Five-Months Motor Coal Delivery.

Various attempts have been made to design a type of motor truck with special body for coal delivery. One of the latest and it is be-



BROOM & WADE 3-TON KEROSENE LORRY.

Single-cylinder 26 horse-power horizontal engine underneath body. Single-chain drive to live rear axle; two-speed planetary change-speed gears.

lieved the most successful results is found in the Hewitt 6-ton coal trucks with side-dumping steel bodies. Although following accepted practice in such matters as vertical four-cylinder gasoline engine, sliding-gear change-speed mechanism, differential countershaft and side chain drive, the designer has made interesting departures in placing the steering wheel and control lever on the left side and suspending the radiator on helical springs to prevent the development of leaks in this delicate organ. The truck not only carries its own load but hauls a trailer loaded with 4 tons more, bringing the hauling capacity up to 10 tons. The amount of work which such a truck and trailer can do is shown by the record of five-months work for Herbert Bros., coal dealers, of New York. From October 30, 1907, to March 28, 1908, the truck was in service 105 days, some of the time with and part of the time without trailer. In the 105 days 623 trips were made, representing a total distance of 2,775 miles, and an aggregate of 3,618½ long tons of coal was delivered. This makes the average tons hauled per day 34. A total of 925 gallons of gasoline and 56 gallons of lubricating oil was consumed. The work of the truck was greatly hampered by delays in loading and unloading, which became so unsatisfactory that it was taken off this service and put on other work. A single example will suffice: On January 14 the time required for loading eight loads comprising 88,600 pounds was 118

minutes, and for unloading the same 353 minutes, or a total of 7 hours 51 minutes, while the total time consumed in going and returning was 4 hours 18 minutes.

Trucks with Horizontal Engine Under the Body.

Practice differs materially in the design of trucks to carry from one to three tons. Use of the double-opposed horizontal engine disposed underneath the body is common in America, and the merits of the construction involving its use, especially for certain classes of work, were given recognition by the British engineers who acted as judges in the Commercial Vehicle Trials conducted in England by the Royal Automobile Club from September 9 to October 12, 1907. Referring to the Broom & Wade 2-ton platform truck having a 26 horse-power single-cylinder horizontal motor, 8 by 8 inches, suspended underneath the body and using kerosene for fuel, and single chain drive to the real live axle from a two-speed planetary gear, the judges, in the course of their report on the trials, made the following observations:

"There would appear to be a future for a type of vehicle suited for delivery work in the country in cases where speed on the road is of secondary importance, where capital outlay and running costs are required to be reduced to a minimum, and where the loads to be carried would not exceed three tons. The majority of petrol lorries (gasoline trucks) being a very high-class engineering product, do not fulfil these conditions, and manufacturers might well turn their attention to a cheaper and slower class of vehicle, an excellent example of which was submitted which, though capable of improvement and simplification, is worthy of special commendation."

Long-Distance Road Performance.

Difficulty of access to the engine and its attachments for purposes of cleaning, adjustment and repair in the type of car having the engine under the middle of the body, has recently turned the course of development noticeably in the direction of the vertical-motor-in-front construction which has become the standard in pleasure-car manufacture. An example of this in light trucks is seen in the Mitchell 1½-ton truck, which is worthy of mention because of a long overland trip that one of these trucks made from the factory in Racine, Wis., to New York City last November, with a load of 3,400 pounds—representing a considerable overload. The distance covered was 1,168 miles, with the roads in miserable condition because of many successive days of rain. Consumption of fuel and lubricants on the journey was: gasoline, 132 gallons; oil, 16 gallons; hard grease,

10 pounds; aggregating an outlay of $39.40. The largest items for repairs on the trip were: resetting a tire, $5; repairs to transmission, $18. This is one of the longest and most arduous demonstrations of the reliability of a motor truck ever made on the road. The engine develops 20 horse power and drives through a sliding gear "transmission" giving three forward speeds and reverse. A very unusual feature is the employment of worm drive to the differential on the rear axle. A worm of coarse pitch is secured to the end of the driving shaft in place of the customary bevel pinion and engages a worm gear on the periphery of the differential group.

Novel French Light Delivery Van.

Much attention has been attracted of late to a novel little gas-engined vehicle with a carrying capacity of 1,000 to 1,500 pounds designed especially for the quick and economical delivery of small parcels in large cities. This is the Roval light delivery van built in Paris and exhibited for the first time at the Paris Automobile Salon

MITCHELL 1½-TON AMERICAN GASOLINE TRUCK, AFTER ROAD TRIP FROM RACINE TO NEW YORK.

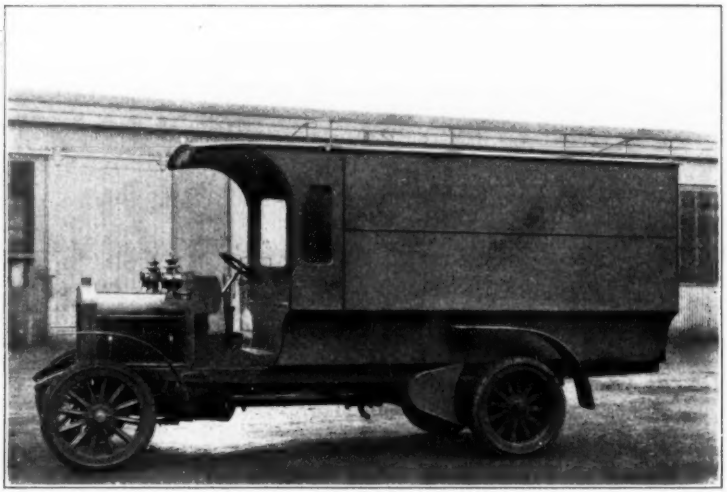
Weight without load, 2,360 lb.; 20 horse-power four-cylinder vertical engine; wheel base 116 in., tread 56 in.; body, inside, 8 ft. by 3 ft. 7 in.; tires, front 30 by 3 in., rear 30 by 3½ in., solid.

ROVAL LIGHT VAN FOR QUICK DELIVERY OF SMALL PARCELS.

Capacity, 1,500 lb.; speed 18 miles an hour; 6 horse-power single-cylinder vertical engine; wheel base 8 ft., tread 4 ft.; width of frame, 2 ft. 4 in.; wheels, tires all 27½ by 3 1/3 in.

last December. The driver sits above the rear axle and has an unobstructed view over the top of the body, which is set on a pressed-steel frame of channel section filled with wood to stiffen it. The center of gravity is so low that great stability is assured, although the tread is only 4 feet between wheel centers. This arrangement also permits of the use of a 6-foot body on an 8-foot wheelbase without any overhang. The pressed side members of the frame are formed in one piece with the sides of the seat support and the web to which the dash is secured, a design that contributes to rapidity and economy of manufacture. All the mechanism is placed at the rear, with the single-cylinder, vertical water-cooled motor and its attachments, such as carbureter and magneto, under a metal cover at the left of the seat pedestal where they are almost as accessible as when on the block, and where the heat and odor can have no effect upon the contents of the van. The fuel tank is attached to the rear of the dash at the left of the steering post. A speed-changing gear set affords three forward speed ratios, while the engine, which develops 6 horse power, is provided with an exhaust-valve control by which its speed can be regulated within the limits of 500 and 1,500 revolutions per minute. The engine and speed-changing gear set are built in a

unit with a differential countershaft which is parallel to and in the same horizontal plane with the crank shaft, and drive is from the ends of this to the rear wheels by chains. The body is loaded and unloaded conveniently through doors in the front.



THORNYCROFT 16 HORSE-POWER 1½-TON BOX VAN FOR DELIVERY WORK.

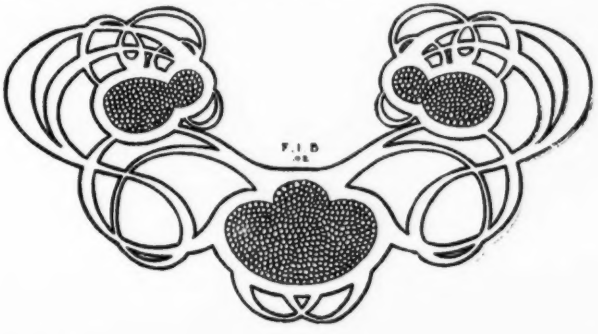
ENGLISH BOX VAN FOR DELIVERY WORK.

A good example of the English type of box van for loads of medium weight is seen in the new Thornycroft 1½-ton van. As high speed is detrimental to commercial vehicles, this wagon has an engine of but 16 horse power and is geared low so that it will have no difficulty in surmounting hills. The two cylinders of the engine are cast together side by side and stand vertically. Inlet and exhaust valves are on opposite sides of the T-shaped cylinder heads. Since delivery wagons are commonly placed in the hands of former horse drivers, the Thornycrofts have endeavored to simplify the construction and operation as much as possible. This is evident in the employment of the natural or thermo-syphonic cooling system, which requires no pump that can get out of order and cause overheating; the use of low-tension ignition which obviates battery troubles and needs no attention; of an oil pump which supplies lubricants to the main bearings and cylinders automatically; and a single engine-control lever that acts simultaneously on the gas throttle and ignition advance. Even a driver having no knowledge of the fundamental theory of the gas engine can have no trouble in regulating his engine with

but one lever to manipulate, since movement of the lever in one direction for increased speed or power both opens the throttle and advances the time of ignition. It is not desired that a driver should try to rush an ascent on high-speed gear, opening the throttle wide to give full charges of gas and retarding the spark to allow the engine to run slowly.

The keynote of simplicity is also evident in the Thornycroft carbureter, which has no float for maintaining a constant level of fuel to give uniform feed at all times, and no jet. The design is very simple, comprising a U-shaped tube to which the fuel is admitted through a valve. This tube is heated by exhaust gases from the engine which circulate within a jacket, and as the fuel and air commingle in the tube they are heated to assist vaporization. After the engine has been started on gasoline and run until the carbureter is hot enough to vaporize kerosene, the lighter and more expensive fuel is shut off and the car run on kerosene. There is no reservoir for fuel in the device, as in the usual float-feed carbureter, and changes from one fuel to the other can be made quickly, so that if it is found that the heavy oil has been turned on too soon, the driver can return to the use of gasoline.

For changes of vehicle speed, selective type gearing is used, which has the advantage of not requiring the passing through intermediate gears in dropping say from high speed directly to low. All forward changes and reverse are obtained by one lever operating in an H-shaped gate on a quadrant. Side chains are used for final drive to the rear wheels, and the front part of the chains and the sprocket wheels on the countershaft are protected by metal chain cases. The single front and twin rear tires are of a type largely used in England, having transverse slots or grooves in the rubber tread to prevent slippage on wet and "greasy" pavements.



A CHARACTERISTIC RAILWAY CONSTRUCTION CAMP; CHAMBERS' NO. 5.

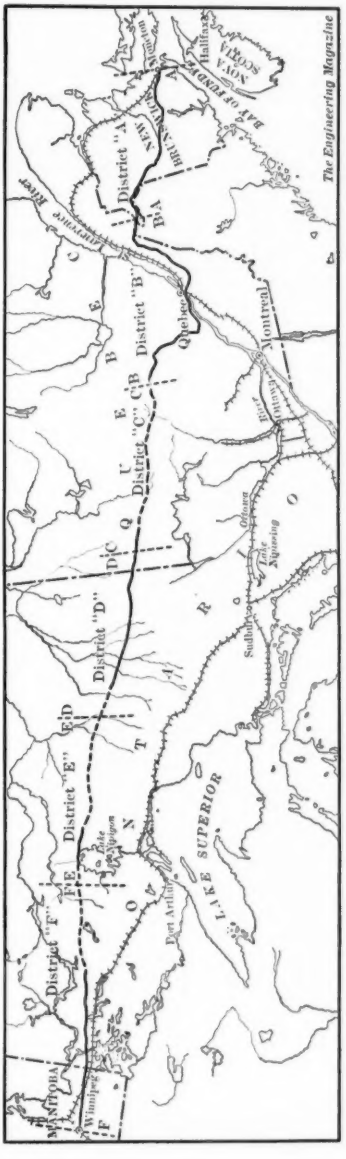
THE BUILDING OF THE NEW CANADIAN TRANSCONTINENTAL RAILROAD.

By George C. McFarlane.

Mr. McFarlane's article throws a vivid light on the difficulties encountered in constructing the Grand Trunk Pacific through the wildernesses of northern Ontario and Quebec. A four-hundred mile section west of Winnipeg has been open for traffic for some weeks, but, despite the vigor and efficiency with which Mr. McFarlane shows the work on the eastern section to be prosecuted, the completion of this great work must still be a matter of years.—THE EDITORS.

THE new Transcontinental which will be known as the Grand Trunk Pacific stretches across 65 degrees of longitude and 8 degrees of latitude, from Moncton, N. B., on Bay of Fundy, to Prince Rupert on the Pacific, the total length of the main line being 3,400 miles. The eastern division, of approximately 1,770 miles, extending from the Atlantic Ocean to Winnipeg, is being built by the Dominion Government, and will be leased and ultimately purchased by the Grand Trunk Co. Construction work, which began in 1906, is being actively prosecuted all along the line; 1,200 miles of the Government section is now let, and on the western division 400 miles across the prairie is practically complete; last spring contracts were let for a hundred miles running out of Edmonton toward the Rockies, and for another hundred-mile section extending east from Prince Rupert along the cañon of the Skeena River.

The eastern division, from the valley of the St. Lawrence to the western prairie, traverses an unsettled wilderness; crossing the Laurentide hills that outline the St. Lawrence valley on the west, the line for 500 miles passes through a fairly well timbered rolling plain,



MAP SHOWING PROGRESS ON THE MONCTON-WINNIPEG GOVERNMENT SECTION TO MARCH, 1908.
The dotted portions indicate located line; the full portions, sections under contract.

which stretches southward from the shores of Hudson's Bay to the height of land; then it passes through 500 miles of rocky Archæan highlands lying to the north and west of Lake Superior, then across 60 miles of prairie to Winnipeg.

It is evident that a private corporation could not afford to build a railroad across 1,200 miles of wilderness, so the Government, after making a comprehensive investigation of the resources of this region, determined to undertake the building. The idea was to build a first-class railroad which should be a direct line from the wheat fields of the west to the seaboard, and with the Grand Trunk Pacific form a short line for "trans-Canada" mail and traffic between England and the Orient, and which in time of need would furnish a military highway, well within the confines of Imperial domain, for the quick despatch of troops and armament from coast to coast. It will open up for settlement a large tract of fairly good agricultural land in northern Ontario, will [illegible] great pulpwood [illegible] as it crosses at Lake Abittibi and also near Lake Nipigon wide belts of mineral-bearing

Huronian rocks, it will probably open up valuable mineral deposits.

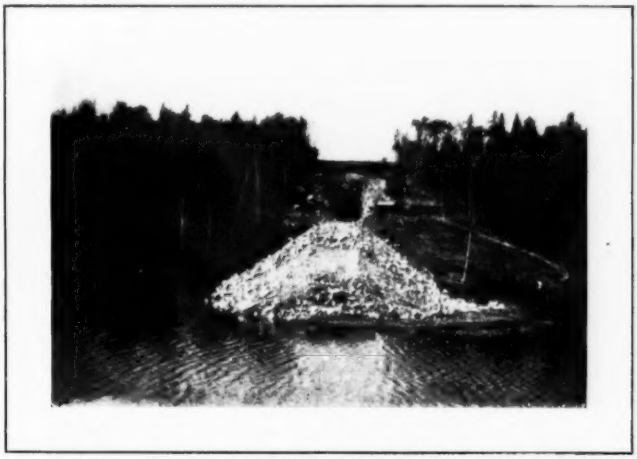
Topographically the whole country is a vast, rolling plain broken up by numerous rocky ridges and bosses, and drained by rivers which are a series of lakes connected by short, river-like stretches. North and west of Lake Superior the country has been ground down to the bone by the glacial ice cap, the rock surface polished and rounded, and some glacial *débris* left in the hollows and depressions. In the basin of Hudson's Bay the rock is pretty well covered with a heavy mantle of marine sediments, which forms a good soil, only occasional rocky ridges projecting above the general level. In the depressions gouged out by the glaciers are myriads of lakes usually connected by shallow streams. These lakes and their connecting waterways furnish routes for reaching all parts of the region, by canoe in summer and by sleigh teams over their frozen surface in winter.

ONE MODE OF TRANSPORTATION USED BY THE RAILWAY BUILDERS.

Owing to the peculiar topography, the engineers experienced innumerable difficulties in getting a fairly direct line through this maze of lakes. From five to ten well equipped parties were in the field for nearly three years before the general route was decided upon. These parties were out winter and summer from fifty to two hundred miles from civilization; in summer supplies were brought in by canoe and left in caches at designated intervals along the route; in winter dog-teams, of which each party had several, furnished the only means of communication with the outside world. Between snow and bitter

cold in winter, and mosquitos, black flies, rain, and muskegs in summer, the lot of a locating engineer was far from a pleasant one.

When the location work had progressed far enough for construction work to be started, the line was divided into six districts each in charge of a district engineer; each district was subdivided into ten divisions, each in charge of a division engineer, and the divisions were partitioned into ten- or twelve-mile residencies. When a section of the line was let to a contractor, engineer camps were built on the residencies within the section; these camps consist of a number of small but exceedingly neat and well built log houses; they are put up by the staff assistants, who as a rule are expert axemen. The residency force consists of an engineer, transitman, three assistants, a force accountman, chore boy, and cook.



TUNNEL AND FILL. SHOWING CHARACTERISTIC TOPOGRAPHY.

Usually the locating engineers are appointed division engineers of construction, and the instrument men of the locating parties are given charge of residencies. Besides the regular engineering work incident to construction, the engineers assist in enforcing the Government regulations for the exclusion of liquor, the prevention of forest fires, the sanitary regulations regarding the building of contractors' camps, and the food supplies furnished the men, and they also see that the contractors' employees receive fair treatment and are paid no less than the minimum wage scheduled by the Government.

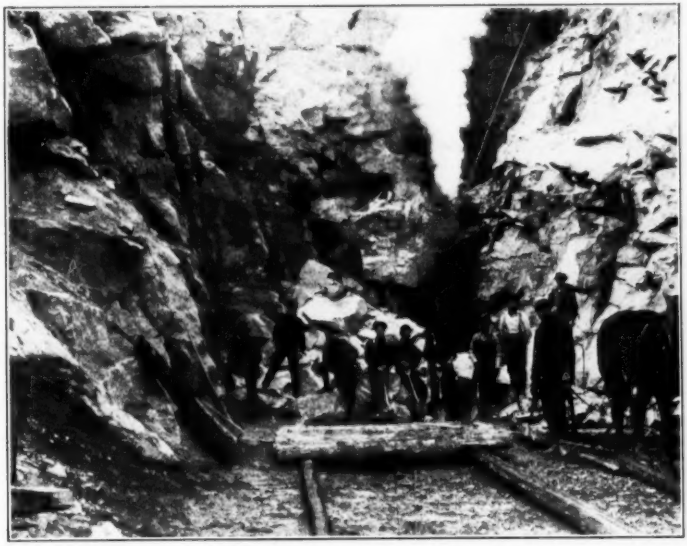
When the Government was ready to begin the construction of the road in the spring of 1906, there was an abnormal shortage of labor caused by the railroads in the Canadian northwest, which were grid-

ironing the prairies with branches and extensions. Under these circumstances the commissioners decided to extend the construction over a period of six years; by letting the work in short sections, starting at convenient points, the completed section would give access to adjacent portions of the line, and these adjacent portions would be let to contractors in sequence. During the flush years of 1906 and 1907, not over nine thousand men were at work on the road; during the present depression double that number of men are given employment at fair wages. It is interesting to note that while wages are 20 per cent lower than they were a year ago, the average efficiency is fully 30 per cent greater. During the good times, when the laborers were being paid as high as $2.25 and $2.50 per day, they seldom staid over a month in one camp, quitting them to find a better job at higher wages; after reaching town and "blowing in," the employment agent would ship them back to another camp at the same wages and in debt for railway fare and employment fee. Some of the laborers would even throw away their blankets and working clothes when they quit a job. As long as the good times kept up and there were more jobs than men, they kept up these tactics; with the coming of hard times in the beginning of the year all this was changed; wages were cut to the base scale, work being scarce men quit shifting around, and now the average laborer stays over six months on a job without going to town and is saving more money than in the so-called good times.

The first section of the line to be let was the 275 miles running from Winnipeg to Superior Junction, where it connects with a branch now being built by the Grand Trunk from Fort William; it was desired to have this section in operation as soon as possible in order to give the western wheat another outlet to the Great Lakes. This 275-mile section has the heaviest stretch of rock grading on the Continent. After crossing 60 miles of prairie, lying east of Winnipeg, the line traverses a region of lakes and low granite hills, and the road, particularly for the first hundred miles, is a continual succession of deep rock cuts and heavy fills over the intervening shallow lakes, swamps, and depressions. It was estimated that this section would cost about $13,000,000 to build, but this estimate will be greatly exceeded, because there has been a great deal of overbreak in the rock cuts and heavy settlements have taken place where the fills cross muskegs and the shallow arms and bays of the lakes skirted by the line; it is therefore probable that this section will cost between $16,000,000 and $17,000,000.

In May, 1906, the commissioners awarded the contract for this section to J. D. McArthur, of Winnipeg, who was obliged to furnish

a cash bond of $1,300,000 for the carrying out of the work. For the purpose of rapidly organizing a working force and carrying on the work as expeditiously as possible, Mr. McArthur sublet the grading of the entire section in small blocks; his field manager, W. A. Dutton, to whom the successful outcome of the contract will be largely due, personally took 58 miles of the heaviest rock work. According to this arrangement the general contractor was the financial backer of the sub-contractors, furnishing them the money for purchasing equipment, paying all the payrolls, furnishing all supplies for boarding and clothing the men and laying down explosives, etc., at convenient points on the Canadian Pacific Railway. All supplies were furnished at cost plus 10 per cent; payrolls were charged up net with 1½ per cent added for indemnity insurance; the general contractor also maintained a field-hospital service for which the subs were charged $1.00 per man per month.



THE FACE OF A 50-FOOT CUT.

The powder men are blowing out the two blast holes in the bottom with steam, preparing to put in the blasting charge—in this case 100 lb. of dynamite in each hole.

All the sub-contractors used the same general methods in carrying out the work. Camps for feeding and housing 80 to 125 men and from 10 to 20 teams of horses were established at intervals of 2 or 3 miles along the line. These camps consisted of log buildings, the logs being laid up in the round, spotted and chinked, and then plas-

tered inside and out with a mixture of clay and lime, and the roof being a single thickness of boards covered with rubberoid paper. The regular camp consists of an office and store building, a warehouse, powder magazine, blacksmith shop, cookhouse, three bunkhouses, and two barns, and costs from $3,000 to $4,000. In order to get in supplies at all seasons of the year, small steamboats were built on the Winnipeg River and on the larger lakes along the line, the portages between these lakes were cut out, and tramways were built on some of the main portages. Winter sleigh roads running south to stations on the C. P. R. were cut from each group of camps.

A HEAVY SHOT.

Most of the work of camp building, road cutting, and right-of-way clearing on the McArthur contract was completed by the end of 1906, and the actual work of rock excavation commenced early in 1907. The organization of the working force was about as follows: the force of each sub-contractor was under the general charge of a walking boss; each camp was directly in charge of a "camp-walker," who divided his force into gangs of ten or twelve men. Each gang was in charge of a gang foreman and was assigned to a cut, which it usually held until finished. The gang foreman is the powder man as well as boss of the gang in a rock gang. One of the men is a teamster, and drives the stone-boat team or car horse; three of the men are drillers, and the remainder of the gang load out the broken rock and trim the dump.

The rock is first broken with heavy blasts. For this purpose a

centre hole is drilled back of the face of the cut; in the big cuts these holes are often drilled 30 or 35 feet deep and set back 25 or 30 feet from the face of the cut. After being drilled the gang foreman chambers the hole by springing it with repeated and successively larger charges of dynamite; starting with a single stick, the springing charges will be doubled or trebled, until, in the case of a 30-foot hole, the final springing charge might be 200 pounds and the blasting charge 800 pounds of dynamite. When such a shot is detonated with a battery the ground quivers, and instantly and almost noiselessly a big haystack of rock rises above the ground level, opens out like a lily, and falls with a clatter into the cut. Possibly 1,500 cubic yards are thrown out, and some of the pieces will be as big as a house and weigh a hundred tons; all these big pieces are broken by block holes or loose dynamite packed tight in a depression of the rock and covered with a mud cap.

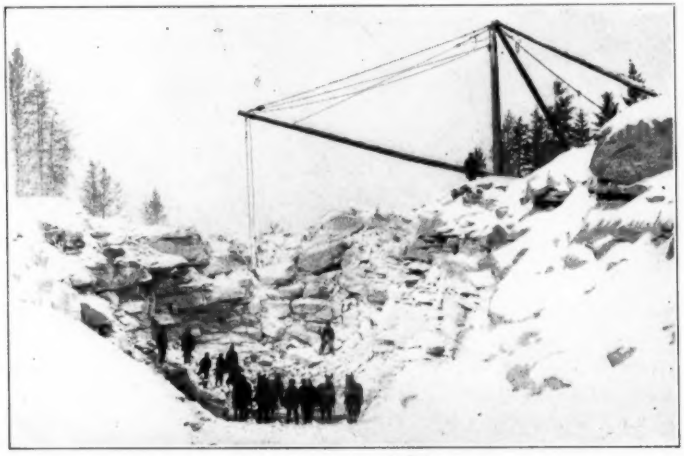
MUCKING OUT FROM A HEAVY CUT.
The tripod in the background is over a blast hole, and is used to steady the long loading stick.

Several methods are used for loading out the rock and hauling it to the dump. Stone-boats running on pole tracks and hauled by heavy two- and three-horse teams are used on short hauls, and in winter when they can be run on iced poles or on the frozen lake surfaces

they are used in nearly all the borrow pits and cuts not equipped with derricks and cars. In nearly all the long cuts low platform cars running on 20-pound steel rails are used; these care are usually loaded with derricks, the small stuff being loaded by hand. Hand and horse-power stiff-legged derricks are commonly used, although a few steam derricks are in use.

As the work progressed, steam-drills were gradually introduced for drilling the big blast holes; they were also used in the tunnels, except in the tunnel near the Winnipeg River crossing, where the Temple-Ingersoll electric air drill is being used with good success. In this tunnel the heading was driven from an incline cut sunk on the east side of the ridge; the east approach proved to be a great mass of quicksand and boulders in an irregular basin-shaped depression of the bed rock.

From the start of the work, the contractors have been replacing the day gangs with gangs of station men, as it has proven by far the most economical method of handling rock. According to this system ten or twelve men band together to take out a cut or borrow pit by the yard; while carrying out the work, they are furnished with all necessary equipment, such as horses, cars, and rails, at a very nominal rental. The station men do not draw any wages, however; they are furnished all supplies, necessary to carry on the work, as well as board and clothing, all of which are charged up at a slight advance over cost prices. When their cut or station is completed, it is measured up by the engineer and the station gang given a prompt cash



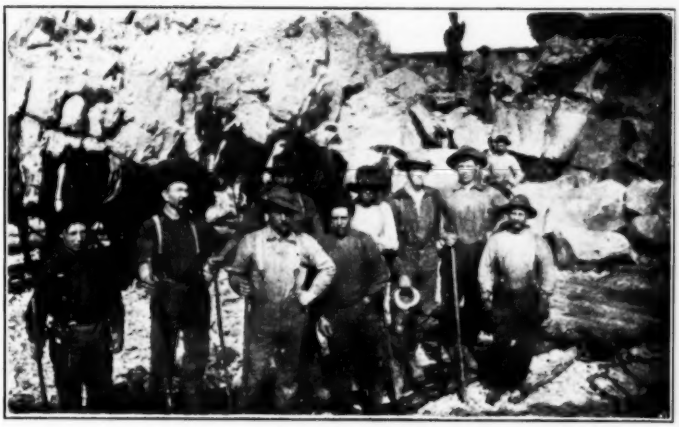
ROCK WORK IN WINTER.

A DERRICK FOR LOADING BLASTED ROCK ONTO CARS. DRILL AT WORK IN THE BACKGROUND.

settlement. The prices received by the station men average 15 per cent lower than the sub-contractors' prices, who in turn receive 10 per cent less than the general contractor receives from the Government. Sometimes three or four extra good men are given a cut and

allowed to hire day hands, receiving regular day wages from the contractor, to assist them. The advantage of working station men is that once the work is let, the contractor is sure of making a reasonable profit on his job; because no matter what difficulties or squabbles a station gang may have, they have to stick it out and finish in order to get any money. Occasionally a station gang may not do enough to pay their expenses; this may be caused by dissensions among themselves, poor judgment in blasting, or the work itself may be poor. Scratch-cuts, clay-cuts, or mixed dirt and rock are considered to be hard propositions for station gangs. As a rule this work must be taken out by day gangs of Austrians, Galicians, and Italians. For the most part, the station gangs are composed of Swedes, with a sprinkling of Norwegians, Finns, and native Canadians; men of other nationalities, while often individually first rate rockmen, do not seem to be able to put up the team play or to exhibit the knack of handling rock to advantage. As a rule a Scandinavian station gang uses very little machinery in taking out rock, preferring to break up the rock by mud-capping and block-holing and loading on the car or stone boat by hand. On the average the station gangs get out more rock in this manner than the day gangs, who are provided with steam drills for drilling the rock and derricks for loading the big chunks. Even among the station gangs the efficiency varies enormously; some of them do not average $1 a day over expenses; the majority average $2.50 per day, and a few clear $7 a day.

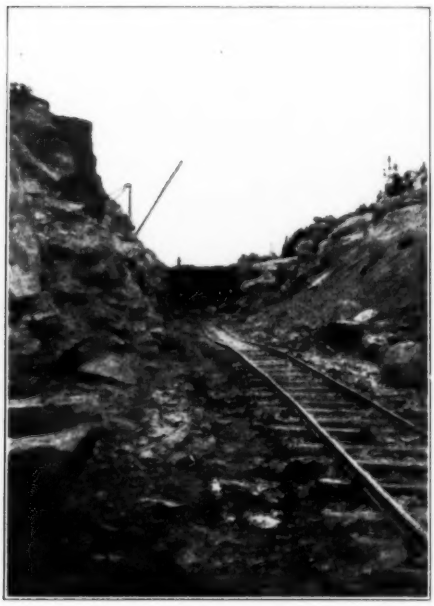
One of the most distressing features of the work is the great number of fatal accidents that are continually taking place, both on the McArthur work and on the rock sections through Quebec and New Brunswick. Of course on this class of work, a good many accidents are to be expected; men loading in the cuts are liable to pick into unexploded pieces of dynamite; they are liable to be caught by rocks or boulders rolling down the slopes; and they are often struck by flying fragments of rock when apparently standing a safe distance away. About half the accidents are caused in this manner and from the careless handling of dynamite; the other half are the result of premature explosions of the big blast holes, when being loaded with heavy springing charges or being tamped up with the blasting charge. These latter accidents are, in a sense, the direct outgrowth of the station-gang system. The rock is nearly all the hardest kind of syenite and granite; hand drilling blast holes in this rock is tedious and expensive; to save expense and get out a lot of rock at one shot, station men will put down one deep hole and keep springing it until they can get in enough dynamite to tear out the rock in front and for per-



A STATION GANG.

They are nearly through their cut, and are mucking out the last big shot.

haps 20 feet behind the hole. This excessive springing in hard, tough rock splinters the hole above the chamber; now in shoving hundreds of sticks of dynamite down the small jagged and splintered hole leading to the bottom chamber, some of the dynamite is bound to lodge in the crevices; the tamping stick, probably jammed by a splinter of rock in one of its numerous trips up and down the hole, might be given an involuntary jerk by the most careful loader, and the loose splinters striking together might detonate the entire charge. I believe this is the true cause of nearly all the bad accidents; my observations lead me to believe that the commonly accepted theory that these premature explosions are caused by loading before the holes have cooled off from previous chambering blasts is absolutely false; neither are they caused by reckless handling of explosives, except in rare instances; the men handling the explosive, almost without exception, along the whole line are intelligent and understand thoroughly all the precautions to be used in handling the stuff. In the more or less decomposed and softer rock usually met with in railroad cuts, the explosive used in chambering a hole pounds the rock around the chamber and along the walls of the hole over the chamber into an inert punky mass and it would be manifestly impossible to rub fire by churning a wooden tamping stick in the hole. The highly elastic crystalline rocks along the line of this road splinter into sharp, angular slivers, and when loose dynamite sifts among these particles and they are agitated by churning a tamping stick up and down, it is no wonder they rub fire and detonate the charge. Again, the mineral crystals composing these



A ROCK CUT NEARLY FINISHED.

rocks often contain microscopic inclusions of gas blebs under high pressure; under certain circumstances the bursting of these gas blebs would cause detonation. After a heavy springing charge is exploded, enormous stresses are developed in the surrounding rock; at times the rock will grind and crackle several minutes after the explosion; it is possible that the rock sometimes does not adjust itself to these stresses for several days—that at times microscopic movements take place in obedience to these stresses after a long interval of time. Supposing such a movement should occur while a hole was being loaded; loose dynamite and angular mineral particles would be scattered along the cracks and crevices radiating around the chamber; some of the mineral particles would be cracked, and the bursting of a microscopic gas bleb might be the locus of a detonation that would extend through the entire charge.

An accident that must have been caused in this manner occurred in one of the big cuts last winter; two holes were placed in the bottom bench of the cut, being fired together with a battery; before the muck was cleared, a squaring-up shot was blasted down from the upper bench. The men after inspecting the shot for a few minutes, started back toward the mouth of the cut to get the tools and rail; before they had gone back two hundred feet, the west bottom hole, which was supposed to have exploded three days before, let go; kicking sideways, it demolished the hoist-engine house on the east bank of the cut. If this shot had thrown ahead it would have mown down every man in the cut.

In the future a good many accidents can be avoided by the contractors adopting a system of machine drilling the rock cuts and letting the blasting and mucking to station men. The machine holes can

be spaced so close that it will not be necessary to load more than one or two boxes of dynamite in any one hole. As the machine holes are much larger than the hand-steel holes, they are much easier to load and there is little danger of the loading stick jamming in the hole.

The only dispute that has arisen so far between the commissioners and the contractors has been over the engineers' classification of the hard, tough clay met with in the approaches of the rock cuts as "common excavation." The rock work so far has been vigorously prosecuted in winter time and nearly all this clay was frozen and had to be blasted; even in summer this clay is so tough and full of roots and rocks that the contractors cannot handle it at a profit. Finally the commission made a ruling that in certain cases the engineers might classify common excavation as loose rock. This ruling has subjected the commission to considerable criticism from the opposition press of the Dominion. Some of these papers have represented that the increased cost of the road over the estimates was caused by over-classification of material. This is a rank injustice to the members of a commission which has directed the carrying out of a great Government enterprise with such signal ability. Practically all the increased cost is accounted for by the overbreak in the rocks cut and the sinking of the grade. The rock is free from cleavage planes and fractures but possesses a large irregular jointing; in order to get solid walls for the cuts, the sides have to be taken back to these joint faces; and when the cut is scaled and trimmed up it will usually show 25 per cent overbreak. On the other hand, while nearly all the lakes had a

ROCK FILL ACROSS A BAY OF LAKE ENA, SHOWING SUBSIDENCE.

The sag in the pole track shows the sink; the foreground was up to grade six weeks before the picture was taken. The lifting and breaking of the ice by mud squeezed up from the bottom is seen on the right-hand side.

fairly hard clay bottom, the 30- and 40-foot fills have sunk anywhere from 10 to 50 feet into the mud and clay.

These fills have taken the over-break, and in many places thousands of yards of rock borrow has been used for bringing them up to grade. The sinking of the fills has been very gradual; most of the sinking takes place under the centre of the dump, and the clay heaved up forms a wide ridge along the sides of the fill. I have noticed places where the centre has gone down 50 feet and big stones along the edges of the embankment would be heaved up 5 or 6 feet out of water. Across most of the bays, before settlement stopped, there was as much rock under as above the original bed of the bay.

For the 200 miles of rock grading between Rennie and Superior Junction the general contractor will receive about $11,000,000; at the average prices paid station men, which is also approximately what it costs to take out the cuts with day gangs, the work will cost the contractors for labor and supplies $8,250,000. Besides this the camps and roads cost $600,000 to build; the horses, cars, rails, derricks, drills, and miscellaneous equipment represent an initial investment of $1,345,000; as all kinds of contractors' equipment depreciate very rapidly, it is probable that all the contractors' plant will not be worth over $600,000; of this the horses will be the principal item. The contractors' administration expenses, which include the salaries of general foreman, walking bosses, shipping clerks, and clerks in the main offices, will amount to $675,000. This makes the total cost to the contractors for executing $11,000,000 worth of rock excavation $10,270,000, leaving a profit of $730,000 or 6.6 per cent. I believe the profit made on supplies and clothing sold to the men would pay the interest on the cash bond, indemnity insurance, and incidentals. The salaries and expenses of the Government engineers in charge of this $11,000,000 worth of grading, by the end of November when the work will be completed, will amount to $370,000, or 3.4 per cent. The preliminary and location surveys for this portion of the line are said to have cost nearly $200,000.

Analysis of the above gives the following sub-division of costs for grading the Transcontinental through 200 miles of heavy rock section:

Engineering, preliminary and location surveys, superintendence of construction	5	per cent.
Contractors' profits	6.25	" "
Contractors' expenses of administration	5.75	" "
Preliminary construction of camps and roads	5.5	" "
Depreciation of contractors' equipment	7	" "
Labor, explosives and supplies	70.5	" "

FUEL FOR POWER GENERATION.

By Edward C. Warren.

In a preceding article Mr. Warren suggested the very attractive—and as he believes, practical—possibility of providing a fuel for internal-combustion motors which should (so to speak) contain its own oxygen and dispense with the now limiting necessity of air supply and compression. In this paper he conducts a radical attack upon the other element of combustion, proposing to replace the common "combustible," carbon, by hydrogen. He admits that this possibility depends upon some new short-circuiting of the cycle of dissociation, by which Nature will restore the combustible to a free state as it restores the flowing water to higher mountain levels; but he believes a way to the solution of this problem can be indicated, and therefore offers his suggestions not merely as interesting, but as potentially of great use and importance.—THE EDITORS.

DURING the month of May of the present year there was convened at Washington, by manifesto of the President of the United States, the most remarkable congress of which American history bears any record. By direct personal invitation of the President the governors of the States of the Union were assembled in conferense with the Nation's Chief Executive to consider what has become a momentous question of immediate vital importance to the whole people—the conservation of natural resources.

Prominent among the gravely threatening aspects of the situation as pictured by the learned investigators loomed the all-important question of an impending famine of fuel substances for the maintenance of the myriad industrial and power-using operations forming the substructure of our civilization. Prominent among the prophets of disaster in his scathing arraignment of national extravagance and indifference to rapidly disappearing resources was Prof. I. C. White, State geologist of Virginia, whose remarkable array of facts and figures proved beyond cavil that, at the present rate of reckless expenditure, our coal measures—those marvelous, Providentially provided deposits of carbonaceous power-wealth—will surely be exhausted within the short space of some 75 years from date. Likewise the oil wells, already falling far behind the demand in the rate of production of their priceless hydrocarbon compounds, must soon be exhausted and the Standard Oil Company close its refineries and pipe lines and turn its attention exclusively to railroads and politics as a source of dividends. Same thing with natural gas, and nothing else in sight to burn.

Now this is, of course, the phase of the question that particularly concerns the power engineer, since he is, collectively speaking, responsible for the existing status and future of the fundamental science of energy-conversion upon which practically all industrial advancement depends.

Prof. White pertinently and forcefully inquires: What are we to do for fuel substances and how are we to generate the mechanical

power so universally required to keep in motion the wheels of civilization when the coal and oil and gas are gone? A pertinent question indeed, and one demanding an early answer if there is to be no break or interruption in the onward march of scientific achievement. For there is no questioning the conclusions of Professor White and other investigators on this point, that the visible supply of the universally used fuel substances is diminishing at a rapidly increasing rate and the time is near at hand when a change must be made if disaster is to be averted.

It is of small avail to urge that a huge, almost incredible, proportion of the fuel taken from the earth is wasted through inefficient methods of utilization, that the best steam-power plants realize hardly 10 per cent of the heat energy of the fuel in the form of useful work on a rotating shaft, that the giant Mauretania with her marvelously complex and highly refined propelling machinery actually realizes in propulsive effect in her progress across the Atlantic a beggarly 5 per cent of the actual power-value of the 5,000 tons of selected coal consumed under her twenty-five boilers in the five-day trip across the ocean. It is quite beside the question to argue that if some of this prodigious waste could be stopped the date of exhaustion of the coal measures might be deferred. The fact is a large part of this wasted fuel could and certainly should be utilized by the employment of improved processes and mechanisms even now available. There is today no valid scientific justification for thermal efficiencies so absurdly low as those quoted, for by the utilization of existing improved systems of generating an expansive motive agent from the combustion of carbonaceous fuels, thermal efficiencies double or triple those now commercially realized may certainly be attained.

This may all be readily conceded by advanced students of engineering science, and yet the fact remains that commercial application must apparently forever lag far in the wake of scientific progression and we must face the fact that any practical material reduction of the rate of dissipation of the fuel supply is, under the circumstances, a remote contingency. Furthermore, the important fact must be considered that any economies effected in the generation of power must inevitably react in an increased use and demand for power, and the cheapening of power simply means a demand for more power, so that it might easily be that the only effect of an application of economy would be an increased demand which would absorb the portion of fuel so saved, and thus the actual date of the extinction of the fuel deposits be unaffected or, possibly, through an over-reaching effect of the stimulating of power consumption, be even brought nearer.

How then is this vitally important problem to be met? Man must use power. Mechanical power, the harnessing of Nature's forces to supplement man's puny physical potential, is the key to all material advancement. Our aim has been and should continue to be to encourage by every possible means the use of mechanical power. A limit to the available supply of power means a limit to human achievement. Yet if the use of power is to continue unchecked and the extension of the application of power in the advancement of man's conquest of the earth is to go on indefinitely, the supply of power must know no limitation.

Generally speaking, the idea of power presupposes fuel; for although it is possible to generate power, theoretically in any quantity, by utilization of solar energy direct by focussing the sun's rays for the concentration of heat, by utilizing the stored energy of the waves of the sea and the rising tides and the moving winds, and while a certain definitely limited although large amount of power may be derived from the natural water powers of the land—still, for the vast field of generally diffused power application, an inexhaustible supply of fuel must ever continue to be regarded as the grand desideratum for the fullest and unretarded extension of the principle of power for performing the work of the world and the lightening of the burden of mankind.

Fuel—the grand desideratum! But the visible supply is strictly limited and going fast,—according to these learned statisticians. But stay! What is it that is going so fast? Coal, oil, and gas. Fuels. But are these the only fuels that Nature has provided? What is fuel, and what is the nature or composition of these substances the deposits of which are stated to constitute practically our sole source of power for general purposes?

Quoting from a recent volume from the pen of Robert Kennedy Duncan, professor of industrial chemistry at the University of Kansas, entitled "The Chemistry of Commerce," the following is of particular interest: "The industries of the world use for fuel only carbon and the compounds of carbon, but other substances may be used instead. This was discovered by Prof. H. Goldschmidt, of Essen, in the use of aluminium for the production of heat."

This is indeed interesting and the "discovery" of Prof. Goldschmidt is indeed most timely and valuable. Fuel then as commonly understood, and those disappearing deposits of coal, gas and oil, are carbon and compounds of carbon; but other substances may be used instead of carbon and carbon compounds! What other substances, and where and how may we perhaps obtain and utilize them?

Let us get down to business, for this is serious business. Of course we all know perfectly well, when we really stop and take stock of our store of facts, that fuel substances are substances capable of uniting with other substances in the phenomenon of combustion. We know, of course, when we refer to carbon as fuel, that carbon is simply a substance capable of uniting with oxygen in combustion with the evolution of heat. That the oxygen which combines with the carbon and without which no combustion of the carbon is possible, is as much a fuel as the carbon. That, as a matter of fact, fuel strictly speaking involves the idea of two or more elemental substances mutually attracted by the mysterious force of chemical affinity which, under certain conditions, causes them to unite in the phenomenon of combustion.

It may be well to mention in passing that we also know that these elemental substances do not lose their elemental character by this process of combustion or union in a new chemical compound, but that carbon is still carbon and oxygen is still oxygen. The process of combustion has merely changed the physical form of one or all and united the atoms of the two or more substances in a new arrangement of molecules. Therefore when we are called upon to consider the question of a fuel supply, the problem before us must be, broadly speaking, to determine upon the elemental substances best adapted by Nature to produce the phenomena we desire, to consider the various involved problems of accessibility, or cost of getting, adequacy of supply, and adaptability to handling, storage, and transportation.

We have observed that carbon and compounds of carbon are universally employed as fuel substances, and it is readily understood why this is so from the fact that the element carbon is one of the most abundant and widely diffused substances in nature, existing in all three of the physical forms of matter—solid in coal, charcoal, and various organic compounds, liquid in the numerous hydrocarbon compounds, and gaseous in carbonic-oxide gas, marsh gas, etc. Its actual availability for fuel purposes is obvious, but for this purpose it appears to possess one serious inherent defect—that when combined with oxygen in combustion it retains the gaseous form acquired in the process, and the cycle by which it is freed from its union with its affinity and returned by Nature to its previous concentrated solid or liquid condition, so as to be again available as fuel, is so slow and complex that the restitution by Nature's own process of the stored deposits of the element in these forms bears no calculable relation to the present or prospective rate of dissolution of these deposits by the demands of civilization.

It is apparently in recognition of these facts that certain, I might say many, of the leaders of thought in this field are today urgently advocating the manufacture of alcohol for fuel and power purposes and are predicting freely that in this direction lies the solution of the fuel problem. The merits of alcohol as a fuel are fairly well understood by combustion engineers. Its manufacture may be considered as a sort of process of "short-circuiting" of the slow cycle of Nature, by which the carbon and hydrogen dissipated into the atmosphere in gaseous form by process of combustion are seized upon in transit, as it were, soon after their divorce from the affinity element oxygen, and hauled ruthlessly back to again be put through the fiery crucible of marital union.

In the issue of THE ENGINEERING MAGAZINE for August, 1908, Mr. Thomas L. White sets forth very clearly the relative advantages of alcohol as a fuel substance and describes an improved process for its production. The significant point is well made that alcohol fulfils at least one essential requirement of a permanent fuel supply. It is theoretically possible to produce it in unlimited quantity and it will therefore be perpetually available. So far so good. We have at least found one source of fuel supply—and a carbon compound too—upon which we may rely to the extent of its adaptability to our needs, with the assurance that the well is not going to "run dry" some time, stop our precious wheels and leave us to freeze. As to the cost per B.t.u of this particular fuel, and the unfortunate fact that we must handle double the weight and bulk of it to develop the same heating power as of the products of natural petroleum, these are quite secondary considerations. The main point for the present is the inexhaustibility of the supply.

But how about other possible sources of fuel? This idea of "short-circuiting" a slow natural process and so establishing an unfailing supply is certainly fascinating. Alcohol is good, but is it the only or the best fuel of which a permanent supply may be thus assured? Going through the list of substances known to be "combustibles" (and the list is long) we find many, nearly all, obviously quite unsuited to general use as fuel substances. We find, in fact, that the two familiar elemental substances, carbon and hydrogen, through their wide diffusion and universal availability and affinity for the oxygen of the air, represent practically the only available substances for general use.

How, then, about hydrogen? We have considered carbon and find that its one grand defect from the fuel standpoint is that when we burn it, it gets away from us in the form of gas and the best

we can do is to win it back through the elaborate "short-circuiting" alcohol process. But, it will be said, alcohol actually contains hydrogen as well as carbon. True enough, but its manufacture, none the less, is a short-circuiting of the carbon cycle. The presence of the hydrogen is incidental, though exceedingly important.

We are familiar with the use of compounds of carbon with hydrogen, but while we deal constantly with carbon as a fuel in itself, while we are familiar with this element in a practically pure state as in anthracite and charcoal, we never hear hydrogen suggested as an independent fuel substance, to be burned as carbon is burned without admixture of any other combustible.

True, it is employed in the oxy-hydrogen blowpipe for the production of extremely high temperatures, and its gas has been used in many and various ways from the filling of balloons to the illuminating of interiors by the hydro-platinum lamp. But as to using this well-known and powerfully combustible element as a substitute for carbon fuels for general power and heating purposes, I cannot find that it has ever to date been suggested. And it is to lead up to and prepare the way for just this revolutionary suggestion that all the foregoing has been laboriously evolved and written.

Hydrogen for Fuel! And why not!

Let us investigate. "Its symbol is H. Its chemical equivalent is 1. Its heating value in combustion with oxygen is 60,000 B.t.u. per pound." So runs the familiar cyclopædic description of this strangely neglected fuel element. But what are the special qualifications of hydrogen as a fuel? Certainly we know it will burn, and we know its heating value per pound is four times that of the best coal; but where are the natural deposits or supplies of hydrogen? How is it to be obtained in any volume commensurate with the enormous demands for fuel, and further, how are we to deal with, handle, store, and transport such a volatile, elusive element? Pertinent questions all; and prompt, sufficient, and conclusive must the answer be if this proposal is to be taken seriously and this paper and the author preserved from the indignant denunciation meted out to hopeless fatuity.

Here are the answers, submitted in all humility but with the confidence born of a conviction that the conclusions herein set forth will be recognized by the profession as clearly and legitimately deducible from long-established facts of engineering and chemical science.

The first and all-important qualification of hydrogen for general use as a fuel substance is that the supply is inexhaustible.

The second and equally important qualification is that its natural cycle through the processes of isolation, combustion, and re-isolation

is so short as to render feasible the continuous re-use of the same volume of fuel substance. It is an ideal "short-circuit."

A third important qualification is the practicability of absolutely perfect combustion. There can be no ash, no smoke or soot, no vitiating gases, for the sole product of combustion is water.

The fact of extremely high heating value per pound of combustible is interesting but relatively unimportant. The commanding merits of hydrogen as a fuel rest wholly upon other grounds.

But the source of supply! Granting the possession of these exceedingly important qualifications, how is an adequate supply of this most volatile of elements to be obtained, and how controlled, transported, and applied? And how about the cost of production? Let us refer for a moment to the second above described "qualification."

Suppose it be suggested that, "the continuous re-use of the same volume of fuel substance" materially alters the aspect of the question of supply. And this brings us to the necessity of enunciating the new conception as to fuel and power—new only in the sense that a theory may be new because never before formulated and put into words though the facts upon which it is based may long have been of common knowledge.

Professor Robert Kennedy Duncan calls it "the new knowledge"—this wedding of science with industry, this application of the newly appreciated but long recorded facts of physical chemistry to the actual work of the industrial world. And it is this "new knowledge"—or rather, in the particular case of power production, this belated application of old knowledge—that is to lead us out of the present existing "chaos of confusion and waste" into a more orderly and rational condition of affairs, whence we may look to the future with confidence, fearing not that our progress may be halted and the very existence of our treasured industries threatened by the exhaustion of some definitely limited natural resource.

The new thought or theory—there is no pretense that it involves new or even special *knowledge*—concerning power and its concomitant commodity, fuel, which constitutes the actual inspiration and foundation of this article, may be embodied in a brief statement conveyed by three words: Power Costs Nothing!

A startling statement, more startling even than the proposal to employ hydrogen for fuel. In fact, the suggestion that this element be used for fuel purposes is merely a corollary of the main proposition.

Power costs nothing! Literally true, though apparently at odds with the most obvious facts of human experience. Power is free.

It is only the harnessing that costs. Obviously true, on reflection, in the case of abstracting power from a water-fall; but when we burn fuel and generate steam to drive engines or when we consume hydrocarbon liquids in an internal-combustion engine, then does not Nature exact an equivalent in fuel consumed for every foot-pound of mechanical energy yielded us, and are we not compelled to expend and exhaust the natural deposits of fuel in order to generate power? Only in the most superficial sense does Nature exact an equivalent, and we laboriously extract and expend these definitely limited and ill-adapted fuel elements purely as a matter of empirical choice and not at all from necessity.

We burn coal, oil and gas simply because some one, a few years ago, observed that they would burn and because certain individuals for their individual benefit exploited these substances as fuel. Is carbon or any available compound of carbon a better fuel substance than hydrogen? Is such material more suitable in any way for the production of heat, light or power? Are such substances more universally available, more readily obtained, stored, transported or applied?

What would be the answer of the physical chemist to such a question? Have the users of fuel, the users of power, ever *asked* the chemist—the only person who has actually any means of knowing—any such question, or has the chemist on his own motion ever considered the problem and offered a suggestion? If so it is not recorded in the history of modern industry. We have simply accepted blindly, unquestioningly, the fuel thrust upon us by those who had it to sell, have paid the price and endeavored with all the cunning of skilful mechanics to devise mechanisms and methods to extract the available heat energy and convert it to our uses. And so long have we pursued this unthinking course, and so schooled have we become in this idea that Nature is niggardly in the matter of her boundless resources of energy and demands that something be destroyed, consumed, or irrevocably offered up as the price of utilizing for a moment the smallest unit of her everflowing cycles of force—something which we call fuel, for which we must dig and pay and which when once "consumed" is gone forever and cannot be replaced—that the very thought or suggestion of free power, costing nothing for fuel substance, exhausting no physical resource or store of material, is only receivable as relating to the accidental and occasional opportunity offered by a flowing stream, a water-fall, the moving wind, or some such manifestation of Nature's restless elements in motion.

Yet it is the purpose of this discussion to insist and demonstrate that power for general purposes, *fuel power*, generated through combustion of fuel, may be and shall be universally obtained henceforth as free of actual power cost, *fuel cost*, as is the case where we harness the energy of Niagara and capture thousands of horse power of energy at the mere expense of the harnessing.

The cost of harnessing is the sole legitimate cost of power. Nature does all the work. Man never "generated" or "took from" Nature a single horse power of energy. When we place a water wheel in the path of a flowing body of water we are simply interposing in the cycle of a natural manifestation of energy. Some well-intentioned but misinformed poet once sang, "The mill will never grind with the water that is past," and we have taken his word for it ever since, though any ancient physicist could have written that the mills of the earth may and do grind over and over again with the water that has passed them many times. The fact is, as we well know, that the mills may go on forever using the same water over and over again, for kindly Nature is continually busy gathering up the spent water and restoring it to its higher level so that its potential energy is again available for man's use for power.

And in precisely the same way is Nature constantly at work restoring to their original form the elements metamorphosed by man's operations in the harnessing of the potential energies of fuels. In the case of "carbon and the compounds of carbon," those fuel substances which are now being "wasted" at such an alarming rate, the impending shortage is due solely to the fact that the "carbon cycle" is a very slow, long, and complex one. The carbon we burn today will be again available as fuel some time in the dim future after it has served its purpose in the evolution of plant life. The only trouble is that when we have caused an atom of carbon to unite in combustion with its two atoms of oxygen, the subsequent natural dissociation of the two elements and the restoration of the carbon to an available concentrated form is such an exceedingly deliberate process, and the intermediate diffusion of the element is so great, as to render the fact and process of such cycle and restoration of no practical benefit to the present generation.

We have already observed how, in the manufacturing of alcohol, this cycle may be "short-circuited" and the carbon recovered long before it has completed the natural cycle which would restore it to the form of coal. And we have observed how the first and most important effect of this is to place in our hands the key to an inexhaustible source of fuel.

Let this then be regarded as the prime requisite of a universal and scientific fuel substance; a short natural cycle. For it must now be plain that if a fuel be employed capable of passing quickly through its cycle of combustion, rarefaction, condensation, and dissociation, we have reduced the question of a source of supply to an absolute minimum; since, as the fuel may thus be immediately recovered and re-used, a supply merely adequate to "stock the cycle" or reach around the circle is all that is required.

Here then, we have the answer to the question as to a supply of the proposed new fuel and the key to its adaptability above all other known fuel substances, for the natural cycle of hydrogen is an ideal "short-circuit." We burn it. It combines with eight times its weight of oxygen. The combustion is perfect and the product of combustion aqueous vapor, immediately condensable and susceptible to ready decomposition and yielding ready to hand not merely our original volume of hydrogen but the oxygen requisite for its immediate recombustion. Is the inference plain? Does not every reader know these facts? and does not every possible question find here its answer —that we shall derive our supply of both hydrogen and the oxygen needed for its combustion from the waters of the earth, that we shall simply insert or interpose our mechanisms or harness in a natural *fuel cycle* and derive unlimited supplies of power by intelligently "short-circuiting" a naturally simple and expeditious cycle of one of Nature's elements.

As to the important question of the particular mechanical or chemical means to be employed in bridging the one natural gap in the hydrogen cycle, the decomposition of the water, this must be regarded as a purely manufacturing operation. That it can be readily accomplished is, of course, as well known as are all the other facts entering into the composition of this new theory of power production. The details of a practical process adapted to the particular requirements of any particular field of power development may well be left for elucidation at another time and place.

It is, however, desired at this time to present only the suggestion that the threatened "fuel famine" is in the nature of a purely imaginary disaster, since we have but to turn from the curiously purblind policy of "seeking afar at great labor and pains" a supply of something which, in far more adaptable form, lies in measureless abundance at our feet, to be had for the taking without labor and without price.

EDITORIAL COMMENT

Panama in Washington.

THE recent domestic aspects of the Panama Canal affairs (as distinguished, that is, from anything contained in an actual survey of the field work) have been marked principally by further investigations and renewed criticisms. The investigations this time are of alleged irregularities in the award of contracts, and the criticisms are a revival of the attack on William Nelson Cromwell as the evil genius of the Administration at Washington. In the former we take no stock whatever. The evidence, the appearances, and the traditions of the military service now in control all lead to the belief that the work is being managed in a fair, straightforward and honorable manner. Of William Nelson Cromwell's relations with the great national undertaking we expressed our opinion four years ago. Whatever his motive or his methods, he succeeded, in a time of great stress and danger, in securing ends most desirable for the nation, but with the acquisition of the Panama Canal from the French company a point was reached where the path of Mr. Cromwell's advantage and that of the country's best good began to diverge

Some of the charges now revived are amusing. Mr. Cromwell, for example, may have used, but certainly did not create and could not have created, the weight of professional opinion before the societies and in technical magazines in favor of the Panama route. That he had any other than proper and permissible interest in the sale of the French property to the United States, is speculative. The price was regarded by unimpeachable appraisers as being very advantageous to the United States, and this judgment has been endorsed by the most impartial judges abroad. If, however, there was any arrangement by which Mr. Cromwell and his associates received much of what was supposed to have gone to the unfortunate French investors, we feel quite sure the facts can not be discovered. But that Mr. Cromwell had a close personal interest in certain claims additional to the $40,000,000, we have strong reason to believe; and we have strong reason to believe, also, that Mr. Cromwell's displeasure fell upon those who opposed the admission of these claims, and that through influence upon the Administration (which influence we consider malign) he succeeded in breaking and sweeping from his path those who advised the Administration against paying for the items in question. Because we believed it to be improper for Mr. Cromwell to be both adviser to the Government and a strenuous advocate for claims adverse to the Government we said in March, 1905: "We seem to have reached the point where the ways fork, and where the interests of Mr. Cromwell and the interests of the country follow different paths. For our part we are unfalteringly loyal to the welfare of the United States, and to the best of our ability we shall endeavor to advance it, wherever that course may lead us. At present, it seems to lead directly away from Mr. Cromwell."

It still seems to us to lead away from him.

Progress on the Isthmus.

THE reports of progress of work in the field at Panama have become less specific during the past year, but general figures of excavation suggest that the maximum possible under the present plan of steam-shovel work has been reached

in the attack on the Culebra cut. During 1906 the monthly total of earth removed in the Culebra section rose from 120,000 cubic yards to 307,000 cubic yards; during the twelve months of 1907 it climbed to 1,025,000 cubic yards; in March, 1908, the climax of the curve apparently was reached at 1,290,000 cubic yards—the dry season this year thus showing a very much smaller proportionate increase than was exhibited last year. In September the total is back to 1,122,000 cubic yards; the average for the year has been barely above the figures for December eleven months ago. According to competent authorities, this is far below the results which should be obtained by a carefully worked out scheme for arranging and advancing the steam shovels and for moving the dirt trains between the shovels and the spoil banks or other points of disposal. If, as has generally been accepted, the time required for the Culebra cut is a key to the time required for the Canal, a higher rate of progress here would mean earlier completion of a serviceable waterway.

Railroad Rates and Efficiency.

IT would be curious and interesting—and also very satisfactory—if, when the excitement of the campaign is over, and public attention returns to the freight-rate question, that question should be found to have disappeared with the disappearance of the deficit which supplied the leading if not the only argument for the proposed advance. In many directions there is already distinct enlargement in production and manufacture, and hence in traffic; and in some of the grain-raising States traffic has already increased to the car-shortage point. It will probably soon become clear to all that the conditions from which the railroads argued the necessity of a substantial advance in freight charges were but temporary and such as they must be expected to endure as part of the common lot.

If this is made manifest the impropriety of raising rates as a remedial measure should be convincingly apparent. It would be less reasonable, indeed, than it would for the steel maker or the copper producer to raise prices when demand fell off.

The question is a large one. The layman who approaches it is warned away with the admonition that he has not the wide and intimate knowledge necessary for its intelligent discussion; but most of those who have this wide and intimate knowledge are necessarily in the railroad service and committed to the railroad point of view. In general, however, typical returns from some of the larger railroads shows an almost level line for the average receipts per passenger mile and only a slight decrease in the earnings per ton mile for many years past, and against the decline in the unit of freight earnings must be placed the reduction in unit costs secured during the twenty-year period by revision of lines, improvement of equipment, increase of train loads, and all the other reforms in which the railroads have taken so much pride. Legislation, further, has protected the roads from the very heavy drafts once made upon them for free transportation, preferential rates, and concessions to large shippers. It is our belief, as we have heretofore urged, that the best and indeed the only course for the railroads to pursue is to push the policy of betterment in operation—of efficiency in every department—through all the broad fields in the railroad organization which are still open to improvement. The way has been pointed in the work already accomplished on some of the transcontinental roads, and recognition of it is apparent in the interest and attention with which the results are being examined by eastern lines. If the period of depression stimulates this movement it will have worked a permanent good for the railroads of the United States.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

SHIPBUILDING IN JAPAN.

A REVIEW OF THE PRINCIPAL FIRMS ENGAGED IN THE INDUSTRY AND THE EXTENT AND CONDITIONS OF GOVERNMENT ASSISTANCE.

Engineering.

IN last month's issue of THE ENGINEERING MAGAZINE we reviewed in these columns an article on the progress of ship owning in Japan, which appeared in a recent number of *Engineering*. We promised at that time similarly to review a paper on the Japanese shipbuilding industry which was announced to appear in the same journal as a supplement to the former article. This promise we now fulfil by the presentation of the following abstract of the comprehensive article on this subject which appeared in *Engineering* for August 21.

"The three principal private shipyards in the country are the Mitsu Bishi Dockyard and Engine Works, at Nagasaki, with a branch at Kobe; the Kawasaki Dockyard Company, at Kobe; and the Osaka Iron Works, at Osaka. There are besides the Uraga Dockyard Company, at Uraga, in Tokio Bay, and the Ishikawajima Shipbuilding Company, at Tokio. These have at certain periods shown signs of great activity, but have at present dropped somewhat out of the running, except for repair work, and for this purpose the former has two fine graving docks. In 1906 the Uraga Dock Company, however, built two torpedo-boat destroyers for the Japanese Government, and last year the Ishikawajima Works turned out three small steamers, the largest 917 tons gross. In the same connection the Yokohama Dockyard Company may be mentioned, a very enterprising and firmly established company, in possession of two good graving docks. Except small vessels, such as steam-launches and motor-boats, this company has not at present ventured upon new construction, although, with some developments, a larger policy would seem to be well within its scope. Scattered throughout the country there were, in all, in 1906, 214 private shipyards, the largest number being in the Osaka district, 38; Hiroshima, 31; and Yamaguchi, 38. Most of these shipyards are engaged upon small craft, in many cases of junk build and rig only; but some undertake wooden steamers, and a few, though furnished with but few machines, consider the building of a steel ship by no means beyond them, the limit of size being, perhaps, 1,000 tons. The engines for these steamers are not very difficult to obtain. General engineering shops of small size are fairly plentiful throughout the country, and any one of these will undertake to build a marine engine when called upon to do so. In some cases the shipyard has a small machine-shop in which to do its own work, obtaining only the castings outside; in others the obtaining of a satisfactory boiler is a matter of somewhat greater difficulty, and the shipyard builds its own boiler as well as hull, obtaining the engines only from outside. The special shipyards that may be mentioned in this connection are:

Oaki's, at Shinagawa, Tokio (which, however, builds only wooden vessels); Ono's and Fujinagata, at Osaka; and Chujio's, at Tosa."

The Mitsu Bishi works at Nagasaki were originally founded by the Imperial Government in 1857 for the repair of small ships of war; they were purchased by the present possessors in 1884. During the first few years following the latter date the output of the works consisted chiefly of small steel vessels ranging from 200 to 700 gross tons. Their most remarkable achievement was the construction in 1895 of the 1,530-ton Suma Maru, the largest steel merchant ship built in Japan up to that date. Following the passage of the Shipbuilding Encouragement Law in 1896 an era of rapid development began. In 1898 was completed the Hitachi Maru, the first steamer exceeding 6,000 tons built in Japan, and since that year progress has been uninterrupted. The output of the works since 1900 has comprised 47 vessels of 117,791 total gross tons and 149,039 total indicated horse power. In recent years this company has built the majority of the ships of the Nippon Yusen Kaisha. A number of the latest vessels turned out by the Mitsu Bishi works have been fitted with Parsons turbines, for the manufacture of which the company holds the sole right in Japan. The works now cover some 114 acres; they are well fitted with complete equipment for building hull, machinery and boilers, and with the special machines for producing turbines.

"The works at Nagasaki are also admirably suited for repairs, possessing three graving docks, with a length on the keel-blocks of 350 feet, 510 feet, and 714 feet respectively, and a hauling-up slip. A branch of the Mitsu Bishi Company was started in 1903 at Kobe, on a scale that will allow of very great developments in the future; at present this branch is laid out principally for repairs. A floating dry dock with a lifting power of 7,000 tons was inaugurated here in 1905. A second dock, for the same purpose, but with a lifting power of 12,000 tons, is at the present time under construction at the Kobe works."

The works of the Kawasaki Dockyard Company also were started originally by the Imperial Government about 35 years ago; the organization of the present company took place only in 1896. The output since that date has been 95 vessels of 55,913 total gross tons. The number of men employed has risen from 1,390 in 1897 to 8,135 in 1907.

"In these works the ships have been mostly of moderate (and even small) size; they have included a large number of gun-boats for the Imperial Government of China, and a steam-yacht for the Government of Siam. During the past year and more, however, two large steamers for the N. Y. K. have been under construction, each with a gross tonnage of some 8,700 tons, and three cargo-steamers of about 6,000 tons for the O. S. K.; the yard and shops are equipped for large work, and contain all the plant needed for the construction of hulls and machinery. There is also a very fine graving dock, 377 feet long on the blocks, besides two hauling-up slips for repairs."

The Osaka Iron Works, including dock and shipbuilding yard, were founded in 1880 and have progressed steadily ever since. "They are spread over various parts of the principal river at Osaka, and comprise engine and boiler shops and a dry dock on the original site, some two miles from the river mouth, a dry dock nearer to the mouth, and the new shipyard at Sakurajima, on the shores of the recently made, and still unfinished, harbor of Osaka." The output since 1897 has been 62 vessels of 31,493 total gross tons. In 1898 the company employed 1,860, and last year 3,282, men.

"Summarising the total shipbuilding output of the country from private shipyards for eight years past, and including sailing vessels above 100 tons, and practically all steamers, the following table may be given:

	Vessels.	
Date.	Number.	Gross Tons.
1900	21	10,763
1901	39	31,771
1902	34	24,769
1903	47	29,591
1904	62	32,612
1905	127	32,858
1906	127	44,452
1907	135	73,632

With regard to naval shipbuilding, to which considerable space is devoted in the article under review, it must suffice to say that the Imperial dockyards are four in number, situated at Yokosura, Kure, Sasebo, and Maizuru. New construction is at present carried out principally at the first two named but the increasing dimensions of warships are severely taxing the accommodations in these yards. The other two, now used principally for repairs, have greater potentialities for extension and they may be expected to assume a much greater importance in the near future. Since 1899 launchings from the Imperial dockyards have comprised 64 vessels of 122,250 total gross tons displacement and 314,225 total indicated horse power.

"The first law for the purpose of assisting the building and owning of ships in 'foreign' style was passed in 1870. The law which is at present in force was passed in 1896, and is to expire in 1914. In its relation to shipowning, provision is made for a payment of 25 sen (6d.) per gross ton per 1,000 miles, to ships under the Japanese flag, engaged in foreign trade, of not less than 1,000 tons (gross) and 10-knots speed. The amount of payment varies with size and speed, reaching a maximum of 60 sen per ton for ships of not less than 6,000 tons (gross) and 17 knots. The amount also varies with the age of steamers, the full sum being due for the first five years after launching, it is then reduced 5 per cent per year up to the fifteenth year, when it is entirely withdrawn. Ships taking advantage of this provision are granted a certificate called the 'Navigation Encouragement Certificate.' For competition with foreign companies the encouragement thus provided proved insufficient, and in 1899 a very important new departure was made. Special contracts were entered into with various Japanese steamship companies to run regular services on certain definite routes. The routes and companies obtaining the advantage of these subsidies are the European, Seattle, and Australian lines of the Nippon Yusen Kwaisha, the San Francisco line of the Toyo Kisen Kwaisha, the more local lines of the Osaka Shosen Kwaisha, and two or three other less well-known companies. For the European line the contract calls for twelve vessels, each of 6,000 tons gross and 14 knots speed; for the Seattle line three vessels, each of 6,000 tons and 15 knots; for the Australian line three vessels of 3,500 tons and 16 knots; for the San Francisco line three vessels of 6,000 tons and 17 knots. The number of steamers possessing the Navigation Encouragement Certificate in March, 1907, was thirty-two, of an aggregate tonnage of 105,000 tons. The ownership of these steamers was divided as follows:

Nippon Yusen Kwaisha, fourteen, of 60,530 tons.
Mitsui Bussan Gomei Kwaisha, eight, of 25,114 tons.
Osaka Shosen Kwaisha, six, of 10,405 tons.
Mitsui Bishi Goshi Kwaisha, two, of 5576 tons.
Government railways, two, of 3359 tons.

"The payment under this head was 961,779 yen* in 1907-8, estimated to be increased to 3,483,955 yen in 1908-9.

"The number of steamers owned by the six subsidised companies under contract to carry out the above-noted services were (early in 1907):

	Number.	Gross Tons.
Nippon Yusen Kwaisha....	78	253,363
Toyo Kisen Kwaisha.....	6	35,279
Osaka Shosen Kwaisha....	100	110,741
Konan Kisen Kwaisha.....	3	3,329
Daito Kisen Kwaisha.....	15	384
Oya Shosen Kwaisha.....	2	3,215

"The amount of subsidies paid in this connection was 6,756,763 yen in 1907-8, and is estimated to be 6,886,300 yen in 1908-9.

"In its relation to shipbuilding the law of 1896 provided for a payment on both hull and machinery: for the hull, when the gross tonnage is between 700 tons and 1,000 tons the rate is 12 yen, and when the gross tonnage is above 1,000 tons the rate is 20 yen per ton; for the machinery the rate is 5 yen per indicated horse-power actually developed upon trial, no payment, however, being made for machinery unless the tonnage exceeds 700, and the hull thereby entitled to its share. Steamers claiming these subsidies must necessarily be constructed in Japan; they must, moreover, comply with the shipbuilding regulations of the Japanese marine bureau. Up to March,

* Yen = 2s. 0.582d., or 49.8 cents.

1907, sixty-seven steamers, of an aggregate gross tonnage of 138,900 tons, had been built to take advantage of this law. Sixteen of these vessels, with an aggregate gross tonnage of 65,436, belong to the N. Y. K., and twenty-one, with an aggregate gross tonnage of 27,572, to the O. S. K.. The payment under this head was 677,348 yen in 1907-8, and is estimated to be 1,995,440 yen in 1908-9."

Mild steel shipbuilding material is produced in Japan only at the Government works near Wakamatsu, which were established in 1901. During the late war all material produced by these works was requisitioned by the Government but recently private builders have been getting a share of the output. Enlargements now under way are expected to increase the annual capacity of the plant to 270,000 tons, two-thirds of which at least will be available for structural purposes. Cast steel is produced in considerable quantities in a number of works.

The keen interest taken in the development of the Japanese shipbuilding industry is attested by the number of students under training in this subject at the Imperial University of Tokio. These now number 115. The course of study extends over three years, and while the practical part of their training is insufficient it is good so far as it goes. The theoretical training is well conceived and adequate.

POWER FOR HARBOR WORK.

A DISCUSSION OF THE RELATIVE ADVANTAGES OF HYDRAULIC AND ELECTRIC POWER FOR PORT AND DOCK MACHINERY.

Brysson Cunningham—Cassier's Magazine.

IT is now about fifteen years since electricity first made its appearance as a serious competitor with hydraulic pressure as a motive agency and source of power for port and dock machinery. The pronounced success of the first experimental plants installed led to the prediction that electricity would in a short time entirely supplant the older form of energy. The field of electricity has been enlarged by great and frequent advances but for certain important classes of machinery the use of hydraulic power still persists and, according to Mr. Brysson Cunningham, who writes on the relative advantages of the two forms of energy in *Cassier's Magazine* for September, is likely to retain its position. We give below a few extracts from Mr. Cunningham's interesting paper.

After a general summary of the prominent characteristics appertaining to each kind of power and to the modes of generation and transmission, Mr. Cunningham considers their special application to port and dock work. "The working appliances of an ordinary port may be broadly divided into two classes, with an intermediate section formed by a few implements common to both. The first class includes all powerful machines for working heavy loads at speeds which are not required to be very great. Such are dock-gate machines, large sluice penstocks, massive swing bridges and coal elevators. The second class comprises light-running machinery, dealing with variable, small or moderate loads at a fairly rapid rate, such as quay cranes and warehouse jiggers, of powers ranging up to 10 tons, but lying generally between 10 and 30 hundredweight. The intermediate division embraces appliances difficult to allocate definitely to either of these, as capstans, winches and the lighter kind of moveable bridges.

"Characteristic of machines of the first-class is their heaviness and uniformity of effort, necessitating gear of considerable strength. Furthermore, they may be said to possess a special and trying environment. Dock gates have to be closed at times in the face of atmospheric conditions of an extremely adverse nature, when any failure of power would be a serious matter. And here lies the advantage of employing the agency of the hydraulic ram, which is exceedingly reliable and simple, without any complex or delicate mechanism to

get out of order at a crucial moment. Moreover, gate and sluice machines lie almost universally below ground level, and in such damp situations, unless special precautions are adopted, there are possibilities of leakage and breakdown in electric cables. It may, therefore, be laid down as a safe and definite conclusion that, in all exposed situations necessitating powerful machinery of fairly uniform capabilities, and, in fact, whenever loads are heavy, constant and slow moving, hydraulic power can be utilized to advantage; and this despite many excellent performances standing to the credit of electric machines devised for these very purposes. The question is not simply one of economy. Considerations of reliability and control are of prior and, indeed, of paramount importance, and they should outweigh even adverse financial reasons, which will not necessarily nor probably arise. Most engineers are satisfied that hydraulic machines are best adapted to this class of work.

"It is in connection with the second class of port machinery that the contest for supremacy is mainly fought, and conditions here are favourable to a more equal and exact comparison. It is relatively a simple matter to set an electric and a hydraulic crane to do work side by side under precisely similar circumstances of service and supply, such as could not possibly be the case with gate or sluice machinery. This has been done in a large number of cases, and we have the benefit of the results recorded.

"But while the quantity of evidence thus collected is not inconsiderable, and while much of it is extremely valuable, it is not infrequently apparent that the whole circumstances have not been taken into consideration. Very often an imperfect comparison is based on actual power expenses without reference to maintenance, and more often still without reference to capital expenditure. It is, on the whole, easy to show a result in favour of electric cranes working under variable loads, if cost of power alone be taken into consideration, for the hydraulic ram is not, as has already been stated, an economical machine for variable loads. Quay cranes which lift up to 30 hundredweights are mostly occupied in dealing with loads much below this limit, and this condition tells enormously in favour of the electric crane. Taking any ordinary class of goods, it is doubtful whether the usual load of a 30-hundredweight quay crane would average more than a ton or 25 hundredweights at the outside. In many cases it is as low as 12 or 15 hundredweights. It may be urged, of course, that this is one of the elements of the situation, and must be acquiesced in accordingly. Admitting this, it may also fairly be contended that other elements favourable to hydraulic power, such as prime cost, should not be omitted. A hydraulic crane costs considerably less than an electric crane, and, therefore, the current amount chargeable to interest and depreciation will be correspondingly smaller. As will be seen, this item plays an important part."

A table is given showing the comparative cost of working an electric and a hydraulic 30-ton crane. The results show a very close approximation to coincidence. Power costs for the electric crane are lower but this advantage is balanced by the lower interest and depreciation charges of the hydraulic installation. Considerations other than actual operating cost, however, throw the balance of advantage in favor of electricity for light quayside appliances. As regards the intermediate group of machines, their motive power will be largely determined by circumstances, both systems being equally convenient.

"Summing up the whole matter, it can confidently be stated that there is still ample scope for the employment of both electric and hydraulic energy in connection with port and dock work, and while electricity seems to have been gaining ground rapidly at the expense of its rival, this is only due to the fact that it is taking up a position of equal importance which has rightly belonged to it from the very first. For the future, the field lies open to both systems to extend their influence along the lines of their natural development, and there is little present prospect of either of them gaining complete possession and control."

THE STUDY OF BREAKAGES.

THE SYSTEMATIC STUDY OF FAILURES AN IMPORTANT SOURCE OF KNOWLEDGE OF THE STRENGTH AND BEHAVIOR OF MATERIALS.

Walter Rosenhain—British Association for the Advancement of Science.

IN an interesting paper read at the recent meeting of the British Association for the Advancement of Science, and printed in *Engineering* for September 11, Mr. Walter Rosenhain, of the National Physical Laboratory, emphasized the importance of the knowledge of the strength and behavior of materials to be obtained from the systematic study of failures of machines and structures. Except in cases where the failure involves the loss of life or limb, such investigations are rarely undertaken, to the great detriment, Mr. Rosenhain thinks, to the progress of engineering knowledge. We give below a brief abstract of his paper:

"The principal argument in favor of the careful study of breakages by modern scientific methods lies in the fact that such study opens up a large amount of valuable knowledge of the properties of engineering materials which is not otherwise obtainable. While in no way underrating the immense importance of the experimental study of materials in our engineering laboratories, it must yet be recognized that such experimental investigations do not, and cannot, reproduce the conditions of actual practice; in fact, for the purpose of rendering the results of the experiments more definite and direct, specially simplified conditions are chosen. In applying the results of such experiments to actual practice, there is therefore a certain residuum of uncertainty which engineers are well accustomed to reckon with by means of factors of safety, or by modifications of design resulting from practical experience of how such things behave in practice. In the great majority of cases these methods succeed in avoiding failure, but, as is well known, this is frequently done at the expense of economy or efficiency. Consequently all fresh knowledge that tends to bridge this gap of uncertainty must represent an improvement of our knowledge of the behavior of our engineering materials, and it is just the study of those cases in which the very fact of failure has shown that not only our knowledge of a definite kind, but our factors of safety and "teachings of experience" together have been insufficient to avoid breakage, that will ultimately enable us to correct our views where they are erroneous or insufficient. This incorrectness of our views may relate to the quality of the material in question, or to its mode of treatment by the manufacturer or user; it may relate to the use of a material good in itself, but not well adapted to the purpose in question, or it may be concerned with the effects of faulty design, defective workmanship, or even of unsuspected or, at present, incalculable stresses. When a failure occurs it may be attributed, according to the ideas or interests of the person concerned, to any of these causes, but only if full investigation takes place and the true cause of the failure is ascertained can the information thus gained be properly employed for the prevention of similar failures in the future. Nor must the manufacturer of materials, be they iron or steel, or other metals, assume that the investigation of breakages will always, or even in the majority of cases, lead either to a condemnation of his product or to the enforcement of more stringent tests; actual practice has shown that in many cases failures result rather from unfair or improper use of material than from inherent defects of the material itself. These are necessarily the most difficult cases to trace, and the investigator naturally inquiries into the quality of the material in the first instance, but in many cases mechanical, chemical, and microscopical tests show that the material itself is of good average quality, and the cause of failure is to be sought elsewhere.

"Again, in another direction the study of breakages may be of direct service to

the makers of engineering materials. A frequent, and indeed nearly always an advisable, method of studying failures is to compare the broken article with a similar one which has given good service—this not only gives the investigator the means of applying the test of actual service to his conclusions, but incidentally it also throws valuable light on the relative importance of the various factors that are insisted upon by various specifications—and the effect upon the specifications is not by any means always in the direction of increased stringency. It is not rare to find that material which from the point of view of the usual specifications would be regarded as superior has failed, while material lying nearer to or even beyond the limits set by the specification has given good service. Of course, it is not suggested that any conclusions as to the correctness of the specifications should be drawn from isolated or even from a small number of instances of this kind, but the accumulation of such data, only derivable from a systematic study of breakages, would undoubtedly lead to a sounder appreciation of the relative importance of the various clauses of our specifications.

"Before passing on to the consideration of the various examples of investigations of failures which are presently to be described in some detail, it will be well to consider some of the principal causes of breakages, and the manner in which they may be detected from a study of the facts and materials of the actual cases; it must, however, be premised that the classification of causes of failure here given is not intended to represent a complete or final analysis of this great question. It is, in fact, only possible, by the use of somewhat vague general terms, to cover the principal classes into which these causes may be grouped.

"According to the stage at which the defect which has ultimately resulted in breakage has arisen, the causes of failure may be classed into three large groups:

Group 1. Defects arising from the manufacture of the material.

Group 2. Defects arising from incorrect treatment of the material during the process of construction.

Group 3. Defects arising during the life of the structure or machine.

The first of these groups is a very wide one, but a few typical cases may be mentioned in connection with steel, the most widely used of engineering materials. Steel may be defective on account of the presence of undue quantities of impurities, but there is a wide difference of opinion as to the quantities which should be considered "undue." Further, the distribution of the impurities through the mass of the metal is of great importance and the systematic study of breakages will gradually elucidate the whole of the vexed question of segregation and its effects on the soundness of the metal. A good deal of information as to the nature of the material in this respect may be obtained by chemical analysis of samples taken from different parts of the broken object and microscopic examinations of sections cut from appropriate parts of the material throw further light on the purity and uniformity of the metal. Mechanical tests, such as tensile, impact, alternating-stress, or brittleness tests, are useful to a certain extent, but it must be remembered that mechanical tests, while accurate and convincing as far as they go, can only reveal the condition of the metal at the time of testing. They cannot be relied upon to determine whether the defect is due to an inherent property of the material or arose from some process or treatment the metal has undergone at a later stage.

The quality of material supplied by the maker depends fully as much on the treatment it has undergone, since its first manufacture into ingots as on its chemical composition. Overheating or even burning of steel are frequent causes of failure. The latter defect may be easily recognized by microscopic examination, although, in case the metal has been heated by the user as well as by the original maker, it will not always be possible to determine at what stage the damage has been done. Overheated steel is readily recognized in the same

way. While the damage done by burning cannot be removed by subsequent treatment, that due to mere overheating may be undone by proper reheating. If this has actually occurred, it may happen that certain pieces or certain patches of a single piece have escaped the refining operation and a weak piece may have been incorporated in a machine or structure. Such weak patches may be very small in area and careful examination of the immediate vicinity of a fracture should be made to avoid overlooking such a point.

When steel is supplied to the user in a partially finished condition, such as forgings ready for machining, many other possible causes of failure may have been introduced. Among these may be mentioned insufficient working by press or hammer, finishing at too high or at an excessively low temperature, and imperfect welding; and unequal heating or cooling of large pieces of metal and insufficient or unduly prolonged annealing. Defects arising from these causes usually show great diversity of structure, sometimes apparent to the eye at the point of fracture and always revealed by mechanical tests and microscopic examination.

The defects arising from improper heat treatment to which reference has been made may also be included in the second of the above groups, which also includes the sources of ultimate failure introduced by the various mechanical processes to which the material is subjected in the workshop. Such processes as punching or shearing may give rise to unsuspected weaknesses. Cold working of mild steel, commonly thought to impair the material very little on account of its great ductility, may be an exceedingly dangerous proceeding, particularly if applied at all locally. Local cold working seems to destroy the ductility, and the resulting brittleness, though local, may cause the failure of the entire piece. Undesirable cold working may usually be subsequently detected by regions of severe deformation. These are readily detected by the microscope and local brittleness is revealed by mechanical tests.

Under the third group are to be found a certain number of cases of failure, in which there is no sign either of defects inherent in the metal or due to injurious treatment; in these cases the metal has been subjected to undue stresses while in actual use. Actual faulty design, in imposing known but unduly severe stresses on sound material, is a very rare cause; a much more frequent and serious one lies in the operation of not readily calculable forces, such as the effects of thermal expansion and contraction in steam boilers and heat engines. Bearings thrown out of line by this or any other cause may set up alternating stresses which may result in the fracture of one of the parts affected. Undue stresses may be thrown on certain parts also by small errors in erection. In the investigation of these cases the fracture itself gives most useful evidence, since the details of the fracture of steel under various types of loading show characteristic differences.

Mr. Rosenhain describes at length four examples of failures investigated after these methods by the National Physical Laboratory, in which definite causes of failure were ascertained: the first, the inner tube of a large gun which developed internal cracks and finally failed, the cause lying in the inclusion in the original ingot of undue quantities of slag; the second, a boiler plate weakened locally by cold working; the third, a locomotive crank pin which had been weakened by a too severe hardening; and last, a failed steel shaft to which an unsatisfactory structure had been given in the forging process. He concludes:

"The above four examples have been taken, as typical cases, from a considerable number of others covering such objects as rails, pump-rods, and other parts of machines. It is hoped that the description of these actual cases may prove of interest to engineers, and may serve to show the extent to which the application of modern methods renders possible the detection of causes of apparently mysterious failures. No doubt cases may arise from time to time which baffle the resources of the investigator,

but under favorable conditions considerable insight into such cases can be gained. These favorable conditions, which can often be realised by careful attention on the part of those under whose authority the fracture has occurred, may be summed up as follows:

1. Full information as to the exact circumstances of the failure, the service already undergone by the part in question, its origin, and any special circumstances concerning it.

2. Careful preservation of the fracture itself and of all portions of the fractured part, in order to avoid the covering up of important facts by the rapid accretion of dirt and rust which so frequently occurs."

THE USE OF STEAM IN THE SUCTION GAS PRODUCER.

THE CHEMICAL REACTIONS INVOLVED AND THEIR INFLUENCE ON THE DESIGN OF A PRODUCER FOR BITUMINOUS COALS.

Philip W. Robson—British Association for the Advancement of Science.

THE discussion on gas-power problems in the Engineering Section at the recent meeting of the British Association for the Advancement of Science centered to a large extent around the suction gas producer. The leading speakers commented on the steady growth of the demand for producers of this type and emphasized the convenience and reliability of the anthracite producer as a source of cheap power supply. A most interesting suggestion was made by Mr. Philip W. Robson, who believes that by proper design and proper regulation of the steam supply the elimination of the tar distilled from bituminous coal may be accomplished in the suction producer without the use of special cleaning apparatus. We give below an extended abstract of his paper:

"The principle of working all suction producers is similar: the gas inlet valve on the engine cylinder is directly connected to the producer, which usually consists of the furnace or generator coupled to a cooling vessel or scrubber. During the suction stroke of the cycle the inlet valve of the engine is opened, and the gas accumulated in the intervening pipes between the engine and the producer is drawn forward into the working cylinder together with a proper proportion of air. A corresponding amount of mixed air and steam flows into the furnace of the producer and reacts there with the fuel, with the result that gas is evolved of an amount equal in volume (after being cooled in the scrubber) to that drawn away. Hence the yield of gas entirely depends upon the suction effect exerted by the engine through the gas inlet valve; the latter being in turn under the automatic control of the engine-governor in the extent to which it is allowed to open causes the amount of gas to be automatically regulated to suit variations of load. All the attention that is necessary, therefore, whilst the plant is working is to keep the generator charged with fuel—an operation occupying from two to three minutes every two hours."

To obtain the highest possible efficiency the gas must be produced with a minimum of heat loss in the producer so that as large a balance as possible may be available for useful work in the engine. The only combustible gas obtainable in ordinary practice, that is, by the partial combustion of the carbon constituents of the fuel, is CO, the reaction being

$$2C + O_2 = 2CO \qquad (a)$$

but the production of this gas is attended by the evolution of 30 per cent of the heat of the carbon reacted upon. To obtain a reasonable degree of efficiency and to prevent very high temperatures in the producer due to the cumulative liberation of heat, with consequent excessive production of clinker and other troubles, the greater part of this heat must be recovered. This is accomplished in a very simple and practical manner by wholly or partially saturating the air supply with steam. The steam reacts with the

incandescent carbon in two alternative ways,

$$C + 2H_2O = CO_2 + 2H_2 \qquad (b)$$
$$C + H_2O = CO + H_2 \qquad (c)$$

and in each case a combustible gas results. In addition to utilizing the liberated heat, the use of steam has the advantage of enriching the gas by the addition of hydrogen produced entirely apart from reactions with air, which in all cases carries four times its volume of inert nitrogen.

The decomposition of the steam begins at a comparatively low temperature, 500 to 600 degrees C. Since it is accomplished by means of the heat resulting from the reaction of the atmospheric oxygen and carbon, it may be said that, in general, the degree to which the reduction of steam according to either equation *(b)* or *(c)* can take place with advantage depends entirely on the amount of heat liberated in the production of carbon monoxide according to equation *(a)*.

By neglecting the radiation losses and heat losses in the scrubbers it is possible to make a simple calculation of the conditions under which the whole of the heat of the fuel can be accounted for in the gas produced. Such is the case if equation *(a)* is combined with equations *(b)* and *(c)* in the following proportions:

$$\left.\begin{array}{l} 2C + O_2 = 2CO \\ 0.95C + 1.9H_2O = 0.95CO_2 + 1.9H_2 \end{array}\right\} (d)$$

$$\left.\begin{array}{l} 2C + O_2 = 2CO \\ 1.18C + 1.18H_2O = 1.18CO + 1.18H_2 \end{array}\right\} (e)$$

Assuming the relative weights to be taken in pounds and the volume of gas produced in cubic feet, the gases produced in these two cases will have the following compositions and properties:

	(d)	(e)
Total volume produced.		
CO	715 cu. ft.	1136.8 cu. ft.
CO_2	339.6 "	
H	679.25 "	420.25 "
N	1430 "	1430 "
Percentage by volume.		
CO	22.6	38.06
CO_2	10.725	
H	21.45	14.06
N	45.2	47.88
Weight of steam per pound of carbon	0.965 lb.	0.577 lb.
Air required per pound of carbon	50.5 cu. ft.	46.8 cu. ft.
Total volume of gas produced	3163.875 "	2987 "
Calorific value per cubic foot	151.5 B.Th.U.	179 B.Th.U.

"In making the foregoing calculations it is assumed that the heat required for steam-raising purposes is obtained from the fuel consumed in the generator, and hence in establishing a heat balance the amount of heat required to vaporise the water has been deducted from the left-hand side of the equation in both cases. The only apparent difference in the efficiency of these two systems, therefore, lies in the fact that in the first more steam is used than in the second. It will be noted that the gas produced in the latter case is considerably richer than in the former.

"It is found, however, that there are further considerations which influence the efficiency of gas producers. At temperatures of 500 degrees C. and over, it is well known that carbon monoxide and steam, and also carbon monoxide and carbon dioxide, may react with each other, such reactions being reversible and depending upon temperature. These reversible reactions are usually written as follows:

$$CO_2 + H_2 \gtrless CO + H_2O \qquad (f)$$
$$C + CO_2 \gtrless 2CO \qquad (g)$$

In both cases the reaction tends from right to left at temperatures under 800 degrees C., above which they take place in the opposite direction; in other words, the carbon monoxide tends to become destroyed in a certain degree as the temperature of the producer is lowered. Further, the combined reaction according to equation *(d)* also tends to take place rather than the alternative according to equation *(e)* as the temperature falls. It is obvious, therefore, that in order to get the highest working efficiency the steam supply should be

regulated so that the temperature of the fire in the producer is kept as high as possible without making excessive clinker, seeing that a richer gas thereby results, and the reversible reactions tending to the destruction of carbon monoxide are avoided Professor Bone and Mr. Wheeler recently demonstrated the truth of this statement in an exhaustive series of experiments on a Mond producer. The fuel used contained 78 per cent. of carbon, and by varying the amount of steam in the air-blast from 0.45 pound to 1.55 pounds of steam per pound of coal gasified, the efficiency of the producer, including the steam for blowing engine, was found to fall from 77.8 to 66.5 per cent. Similar comparative results may be expected from a suction producer, and this drop of efficiency would appear to be due chiefly to the influence of the reversible reactions referred to. The efficiency of a good suction producer varies from 85 to 90 per cent, according to the conditions under which it is worked.

"The importance of properly proportioning the steam supply will be appreciated; otherwise, the best results cannot be obtained, and this is one of the points to which further attention might with advantage be given by gas plant designers. Given a properly designed producer, however, the conditions of highest efficiency can be automatically and continuously obtained without the slightest trouble whilst the plant is being worked by an ordinary attendant.

In the suction producer successful working depends also on the absence of any restriction to the flow of the gas from the furnace to the engine. A restriction causes a reduction of the weight of the charge drawn into the cylinder and the loss of power may make all the difference between success and failure. Simplicity in all directions is the essential condition for successful working. It is, however, difficult to attain in a suction producer for use with bituminous fuels. The tarry matter in the volatiles distilled off, unless previously removed, condensing in the scrubber and mains, quickly clogs them up, and, in addition, sufficient tar may reach the cylinder to interfere seriously with the working of the engine. The introduction between furnace and scrubber of sufficient cleaning apparatus to extract the tar would greatly increase the frictional resistance to the passage of the gas and would otherwise destroy the essential simplicity of arrangement.

"Attention has naturally been turned, therefore, to various methods by which the tar trouble can be eliminated, with the hope that it might prove possible to transform the condensable tarry vapors into fixed gases in the generator, so that the difficulty of tar extraction and additional cleansing apparatus generally could not arise at all. Attempts have been made to decompose the tar by working the producer on the down-draught principle, which has the effect of compelling the volatiles to pass through the hot zone of the furnace before leaving the producer. By another plan the gas outlet is in the middle of the producer, and air is supplied both at the top and at the bottom, the action which is aimed at being to use the upper half of the producer as a down-draught furnace for distilling and fixing the volatiles, while the lower half is supplied with the residual coked fuel, and works as an ordinary up-draught furnace. It is, however, extremely doubtful whether a successful solution of the difficulty will be arrived at by either of these two methods. In pressure producers many plans for reducing the tar within the producer by passing the volatiles through the hot zone of the furnace have been carefully tried from time to time, but without a sufficient measure of practical success to warrant the permanent adoption of any of them for use with bituminous steam coal such as is available here. There appears to be no reason for thinking that modifications of these proposals when applied to suction producers will prove to be more efficacious.

"The calculations previously given in this paper would appear, however, to suggest a better method for attacking the problem. It has been shown that all the sensible heat liberated by the combustion of the carbon of the fuel with the oxygen of the air could be absorbed

by the reduction of the steam passing into the furnace along with the air, and that the precise amount of steam which can be reduced depends entirely on the amount of heat which is so liberated. Further, when we account for the whole heat of the carbon in this way, and take into full consideration the diluent effect of the nitrogen which is unavoidably present, a gas of sufficient calorific value results for use in the engine cylinder.

"There would, therefore, seem to be no reason why the furnace of the producer should not be devised in such a way that the volatiles are absolutely burnt out after being distilled, the heat of this combustion being afterwards recovered by the decomposition of steam under the conditions already described. The final heat balance would be exactly similar to that established by the combined equations already given, and in practice a gas of about 150 British thermal units calorific value might reasonably be expected, and which is quite suitable for engine work. By such a method the tar would undoubtedly be eliminated, whilst the efficiency of the system would be high. There are several designers at work on producers of this character, and when the proper proportions and other practical details are understood a considerable measure of success may be hoped for; the simplicity of the cooling and scrubbing arrangements under this system gives good promise of the feasibility of evolving a practical suction plant for use with bituminous fuels. The ordinary plant, however, for gas coke or anthracite may still be expected to hold the field for units up to 100 brake horse-power."

A NEW METHOD OF EXTRACTING OIL FROM BOREHOLES.

A DESCRIPTION OF THE LEINWEBER PROCESS FOR HOISTING OIL BY MEANS OF AN ENDLESS TRAVELLING HEMPEN BAND.

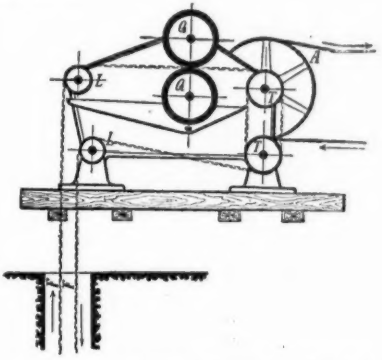
Scientific American Supplement.

A NOVEL process for extracting oil from boreholes to meet special conditions at the Kryg oil field of the Galicia-Carpathia Petroleum Company in Austria has recently been evolved and put into successful operation by Mr. Bruno Leinweber, an engineer of Vienna. This field, the wells of which belong to the "non-spouting" class, is situated in a very inaccessible part of the country, and the ordinary types of pumping machinery could be used only with considerable risk to the continuity of operation of the plant, owing to the difficulty of effecting repairs or renewals in its isolated situation. The laying down of elaborate pumping installations was avoided by Mr. Leinweber's simple process, of which we take the following description from the *Scientific American Supplement* for September 26.

"Briefly described, the Leinweber system consists of the lowering of a band of suitable material into the borehole and the passing of it through the liquid, whereby a certain quantity either becomes absorbed by the cable or clings to it, by which means it is hoisted to the surface and squeezed out by passing between rollers, the extracted oil falling into a suitable receptacle below. By connecting the ends of this band together an endless cable is procured, which, together with a continuous drive, enables extracting to be carried out uninterruptedly. The principal advantages of this system are that the band can be lowered into the narrowest fissures, the width of the band being designed to suit the conditions. The simplicity of the apparatus in both design and operation reduces the risk of breakdown to the minimum. Its applicability to the raising of any description of crude oil, whether thick or fluid, irrespective of the presence of sandy or other foreign substances which in a pumping plant are liable to cause clogging of the apparatus, is universal. Its highly efficient yield is secured with the minimum of expense.

"The general design of the apparatus may be gathered from the accompanying diagram. The endless band traveling up

and down the borehole is represented by *F*, in the pit, the lower end passing through the oil deposit. The ascending cable after issuing from the borehole passes over the upper pulley leader *L*, then between the pressing rollers *Q*, round the winding sheave *T*, and thence into the borehole again over the lower pulley leader *L*, the mechanism being driven through the pulley *A*. In the case of the apparatus for the Kryg oil field, a few minor modifications had to be made in this design to coincide with local requirements, but fundamentally the principle is the same throughout. As will be seen, the whole of the apparatus is carried upon a timber frame, which can be placed at any desired height above the ground. The Kryg apparatus was constructed in the railway workshops at Reichenberg, Bohemia, under the superintendence of the railroad engineer, Mr. Oskar Forster, and was sent to the oil field ready for instant use upon arrival. The fact that the mechanism can be dispatched to any inaccessible point ready for immediate operation constitutes a prominent feature of the invention.



ELEVATION OF THE LEINWEBER APPARATUS.

"The endless band employed has flattened sides similar to those used on elevators, and up to depths of 1,640 feet is manufactured of hemp, being 3 inches wide by 0.31 inch thick, having a breaking strain of 9,240 pounds. This band is covered with carpet shag 2.36 inches wide by 0.078 inch thick, the pile of which offers a greater absorbing surface to the oil. For depths exceeding 1,650 feet a steel wire band is preferable to the hempen cable."

The first tests at Kryg were made under a number of disadvantages. The borehole at which the apparatus was first set up was nine inches in diameter and 2,000 feet deep, but owing to the severe cold the upper part only of the pit could be used and the band had to be considerably shortened. The carpet shag had become frozen and clogged with snow and considerable difficulty was experienced in lowering it into the pit, an operation which occupied about ninety minutes. The winding jack was operated by hand and the highest speed attained was 8 inches per second. The operations of carding out the carpet shag after passing through the mangling rollers and of removing the oil clinging to the edges of the band by means of scrapers were dispensed with. Despite these disadvantages, however, a yield of about 4.86 ounces per foot or 658 pounds per hour was obtained on oil rendered by the intense cold about the consistency of fruit jelly. "As the band became better adapted to the work, the yield increased to 6.13 ounces per foot or 763 pounds per hour. Subsequently steam power supplanted the manual labor, and at a speed of 3 feet per second the output at 6 ounces per foot rose to over 3,518 pounds per hour, giving a total yield per day of twenty-four hours of 84,432 pounds." The apparatus is now operating continuously at another borehole at a depth of 2,000 feet with entire success.

"It has been found necessary to reduce the absorbing capacity of the band, since when operated under the most economic conditions, the yield of the apparatus exceeds the capacity of the borehole. For instance, with a band approximately 5 inches in width by 0.5 inch thick, covered with shag having pile one inch in thickness and driven at 15 feet per second, the yield is 3.66 pounds of paraffin per foot per second, which is equivalent to approximately 396,000 pounds per hour. Since the construction of the machine above described and now in operation at Kryg, the inventor has considerably reduced the proportions of the

band, and at the same time reduced the driving speed, so that the band may be rendered more durable with an added freedom from breakdown. Owing to the nature of the material used for the band, it can be lengthened or shortened according to requirements with facility and expedition, since the joints are effected merely by cobbler's thread sewn either by hand or by an ordinary saddler's machine. It has been found too that at no matter what speed the apparatus is driven, there is always a comparative absence of vibration, and that as the band becomes saturated with oil it runs still more smoothly, with an increased adhesion at the winding sheave, with less stiffness in the rope. Owing to the increased weight of the oil-charged ascending rope, it maintains an almost vertical line in the borehole, so that no losses are incurred by friction with the sides of the pit. The Kryg machine before being sent to the oil fields was submitted to severe tests with an overload of 2,500 pounds beyond the 550 pounds which was the stipulated weight of the ascending cable when charged with oil, and the band did not show the slightest signs of slipping or jerking during elevation to the surface at the highest speeds."

The Leinweber apparatus can be applied to any type or size of borehole by simply altering the dimensions of the rope. The presence of sand in the oil does not interfere with its operation in the slightest degree. Its efficiency can be regulated within wide limits by varying the speed, the width of the band, or the thickness of the pile covering, while the denser the fluid it has to raise, the greater the yield per foot at normal speeds. No part of the mechanism is liable to derangement, the only wearing part being the band, which can be repaired at any time without dismounting.

The withdrawal and insertion of the band are simply and easily effected, by securing the descending or ascending side of the band to the frame of the machine. Water in the borehole is drawn up with the oil and is easily eliminated, while sand suspended in the oil is removed by a steam or water flush. With the band running continuously there is no danger of the borehole becoming obstructed. The apparatus automatically locks the band in case of breakage and stops the winding sheave in case any undue strain is brought upon the rope. Once set in operation, the apparatus requires no further attention whatever beyond the periodical inspection of the cable, which can be followed while travelling, so that it can be run day and night without cessation.

AN ELECTRIC HARDENING FURNACE.

HARDENING IN A BATH OF A FUSED METALLIC SALT IN THE FURNACE OF THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT.

C. R. Straube—Elektrotechnische Zeitschrift.

THE difficulties of hardening high-speed steels were very clearly summarized in Mr. O. M. Becker's article on the barium-chloride hardening process in the August issue of this magazine. The very important influence on their properties of small temperature differences in heat treatment was pointed out and it was shown that the method of hardening by means of a fused bath of barium chloride or other metallic salt offers greater opportunity for close temperature regulation than any of the older methods. Mr. Becker described a gas-fired furnace which, he says, is well adapted for use with this process. In the *Elektrotechnische Zeitschrift* for August 6, however, C. R. Straube describes an electric furnace controlled by the Allgemeine Elektricitäts-Gesellschaft of Berlin, which would seem to possess marked advantages for this work over the various types of externally fired furnaces. We give below a brief description of this furnace and its operation.

The bath of fused metallic salt is contained within a firebrick crucible, in two opposite sides of which are fixed electrodes of iron very low in carbon,

the melting point of which is at 1,500 to 1,600 degrees C., higher than that of any steel. The crucible is entirely surrounded with a thick layer of asbestos which in its turn is imbedded in a layer of some refractory heat-insulating material, the whole being held together by a steel case. The walls of the furnace are built of such a thickness in relation to the dimensions of the crucible that after 10-hours' operation at a temperature of 1300 degrees C. the steel case may be touched with the hand without injury. Heat conduction is thus reduced to a minimum.

The soft iron supply conductors to the electrodes are connected to the secondary copper bars of a regulating transformer, which transforms the normal voltage (110 to 550 volts single phase) to the low voltage (5 to 70 volts) employed in the operation of the furnace. Auxiliary electrical apparatus consists of a controller attached to the transformer, a throw-over switch and a small switchboard. The latter carries a circuit breaker for the primary main, an ammeter and a voltmeter. A typical arrangement of the hardening equipment of a large works has the furnace, provided with a hood, in a central position, the auxiliary electrical equipment on the one side and the quenching tank immediately beside the furnace on the other. By this arrangement temperature change in carrying the pieces from the furnace to the tank is reduced to a minimum. Heating and cooling coils in the tank are supplied with steam or cold water so that the temperature of the quenching bath may be regulated at will.

A pure metallic salt or a mixture of several salts is placed in the crucible and fused by the passage of an electric current. The salt used is varied according to the nature of the steel to be treated, the desideratum being to employ a salt or a mixture with a melting point very close to, but below, the eutectic temperature of the steel. Thus, potassium chloride, fusing at 775 degrees C., is used for carbon steels, barium chloride, fusing at 950 degrees, for high-speed steels, and mixtures of the two give intermediate temperatures. For temperatures between 200 and 400 degrees potassium and sodium nitrates may be used, and for temperatures between 1300 and 1600 degrees, fluorspar and magnesium fluoride. The fusion of the salt is brought about with the help of a moveable electrode and a small piece of arc light carbon which is placed in the circuit between one of the fixed electrodes and the moveable one, the latter being connected to the other fixed electrode by a cable. Sparking between the carbon and the moveable electrode causes the salt immediately adjacent to melt and very soon a circuit is set up through a part of the salt. As the moveable electrode is gradually drawn away it leaves behind a streak of melted salt which is extended by degrees to the opposite electrode. When this point is reached the fusion of the remainder proceeds at a rapid rate.

The temperature produced depends, of course, on the voltage employed. While the bath is being melted a higher tension is required to overcome the higher resistance than during normal working. The temperature may be varied by altering the intensity of the current, and this is easily accomplished by means of the regulating transformer which is so constructed that a certain number of primary windings may be switched on or off. The regulating controller has two contact paths, each with five contact points. The gradations between the points on the lower path are subdivided through the whole of the upper path, so that 25 different intensities of current and degrees of temperature may be obtained by the use of the controller alone. This number may be doubled by bringing in another group of coils by the simple throwing of a switch. The 50 degrees of temperature available through manipulation of the switches may be varied through very small gradations by the use of various salt mixtures. Electrolytic effects are hardly perceptible at a frequency of 25, while they are practically absent at a frequency of 50.

Recently a new design of this furnace has been perfected which permits of the direct connection of the transformer to a three-phase system. In the transformer

the three-phase current is changed by the Scott method into two-phase current. The latter is supplied to the bath through four electrodes, one on each side of the crucible, so that the three-phase furnace is really a combination of two two-phase furnaces. The temperature can be made practically constant throughout the bath. It is easily adjusted to within 10 degrees of that required by means of a suitable pyrometer, a piece of apparatus which is essential to the successful working of any hardening plant. A layer of about 10 millimetres below the surface of the bath is from 10 to 20 degrees colder than other parts but throughout the remainder no greater variation than 3 degrees has been found.

In externally fired furnaces the heat losses are always very large, particularly at high temperatures, and only a fraction of the total energy used in heating the muffle is utilized in raising the temperature of the metal. A further disadvantage of the gas- or oil-fired furnace is that when used at high temperatures the crucibles are rapidly destroyed. A temperature of 1350 degrees is attainable for laboratory tests but is not usually practicable for commercial hardening. Even at this temperature, however, the damage to the crucible of the electric furnace is very small. Working ten hours per day, the walls last for six months and at lower temperatures, for nine months or longer.

THE PROBLEM OF AERIAL NAVIGATION.

THE POSSIBLE UTILITY OF AERIAL FLIGHT AS AN AGENCY IN COMMERCE.

Prof. Simon Newcomb—The Nineteenth Century.

IN a long article in *The Nineteenth Century* for September, Prof. Simon Newcomb, President of the Astronomical and Astrophysical Society of America, discusses the possibilities of aerial navigation as an agency in commerce and for military purposes. It might be thought, he says, that there can be no better ground for now limiting what may be hopefully expected from the "conquest of the air" than there was a century ago for limiting what could be expected from the development of steam navigation. Reasoning from general principles only, he shows that the difficulties in the way of rendering aerial navigation of importance commercially are entirely dissimilar to those which have been overcome in perfecting the steam engine, the telegraph, or the telephone. His dispassionate conclusions as to the practical utility of aerial navigation, should the airship ever reach a stage of development approaching the limit of possible improvement, are in most refreshing contrast to the highly imaginative predictions indulged in by many writters.

In the first place Prof. Newcomb draws attention to the distinction between advance in knowledge and progress in invention. To the possibilities of the future of knowledge, or to the results which may be reached by its advance, no definite limit can be set. If some means were to be found for controlling or reversing gravitation, if radium could be produced for power purposes by the ton instead of by the milligram, if some metallic alloy could be found having ten times the tenacity and rigidity of steel, all our forecasts relating to future possibilities in the application of power would have to be revised. Inventors, however, are not seeking to discover new sources of radium, to find new alloys, or to bring out laws of nature hitherto unknown. They are accepting physical principles and the facts of engineering as they now stand. Forecasts of the possibilities of aerial navigation must be based, therefore, upon the present state of science, and can relate only to what is possible through invention being continued on the lines it is now following.

During the last century the application of power has been approaching fairly well defined limits which can never be extended except by some revolutionary discovery of which there is now not the slightest indication. There

is a certain amount of energy stored up in fuel, which may possibly be utilized in the application of power. A great problem of invention has been to reduce to the minimum waste of this energy. There is a limit to the power which can be exerted by an engine of a given weight, a limit which is being approached in the light airship motors. The resistance and supporting power of the air are phenomena which no invention can change. No progress in invention will increase the weight which a given volume or surface of air will support at a given speed, nor can the resistance experienced by a surface in moving through the air ever be reduced below the point set by physical theory. Prof. Newcomb, however, presupposes an ideal vehicle, one in which every part is so nicely adjusted that the maximum of efficiency is reached with the least possible weight, and the best devices used to diminish friction and insure the application of all the power available in the fuel to the purpose of driving.

Two systems of navigating the air are now being developed, the one that of the flying machine, of which the only form yet found feasible is the aeroplane supported by a rapid movement of translation; and the other, the airship proper, floating in the air by its own buoyancy and not held up by propulsion. There are several drawbacks to every form of flyer which, taken together, would seem to throw it out of the field of competition. The greatest of these drawbacks is inherent in the theory of its support by the air. It must present to the latter a horizontal surface directly proportional to the entire weight to be carried, including motor, machine and cargo. Any enlargement of the machine must, therefore, be in a horizontal direction; a machine, for example, to carry two men instead of one must have its superficial extent doubled. It is readily apparent from the dimensions of the present successful flyers that any important enlargement would necessitate a practically unmanageable area of supporting surface with a consequent weakening of the machine. Fuhther, to secure the necessary strength, every extension must involve increased weight per square yard, which will be less and less compatible with its performance.

The flyer, supported only by its motion through the air, can never stop in flight to have its machinery repaired or adjusted. This disability constitutes a practical difficulty which seems insuperable. No engine built by human skill can be guaranteed against accident, much less the delicate motors necessary in the flyer; and a transportation vehicle, the slightest accident to whose propelling machinery involves in all probability the destruction of the vehicle, as well as danger to the lives of the passengers, can hardly be expected ever to prove of great practical utility. Another serious limitation upon the flyer is that it cannot be navigated out of sight of the ground, and must descend at once if enveloped in a fog, this necessity arising from the deviation of the apparent direction of gravity which must be produced by any change in the inclination of the supporting surface, through the consequent acceleration or retardation of the speed.

Neither of the first two drawbacks mentioned above is incident to the airship. As her buoyant power is proportional to her cubical contents and not merely to her superficial surface, she can be enlarged in thickness as well as in length and breadth. Further she may possibly stop for repairs while the flyer never can. This faculty carries with it a large range of possibilities which make the problems of airship navigation, neglecting the differences in the supporting media, to a certain degree analagous with those of steam navigation. In the latter it is axiomatic that the larger the ship the more economically can a ton of cargo be carried at a given speed. The same principle applies to the airship. The larger she can be built the more economically she can be driven when we measure economy by the ratio of carrying power to cost of running. The limits to her possible size cannot be set by any principles of physical science. The question is simply one of constructive engineering—how large can a manageable airship be built?

But it may be inquired whether the cheapening of transportation by steam power during the last century has not practically done away with all the supposed advantages of flight through the air, which appeared in so strong a light to former generations. Careful thought will show that, leaving aside exceptional cases, like that of striving to reach the Pole, the substitution of aerial for land and water transportation is at bottom the substitution for the solid ground of so imperfect a support for moving bodies as the thin air. In rail transportation the greater part of the propulsive power is expended in overcoming the resistance of the air. An airship of the highest possible perfection, if presenting to the air no greater surface than that of the train, would encounter a large fraction of the same resistance when traveling at the same speed. But, as a matter of fact, owing to the necessary size of the airship of equal capacity, the resisting surface would be vastly greater and the means of overcoming this resistance by adequate propulsive power would be more imperfect and expensive. In addition, fuel consumption would be greater in the airship capable of carrying the same burden as the train, on account of the increased propulsive power required.

This view may appear in conflict with the principle already mentioned, that increased economy will be gained by increasing the size of the airship, but it must be remembered that the economy is measured by the ratio of cargo carried to fuel consumed. It must always cost more to run a large ship than a small one. Economy is gained only when we increase the dimensions of the airship so that she will carry more cargo than the ocean steamer or the railway train. The projector of an airship who would successfully compete with the steamship in ocean traffic must not permit his modesty to suggest beginning with dimensions less than a length of half a mile and a diameter of 600 feet. His ship might then be able to carry some 10,000 tons of cargo or 15,000 passengers, and it would be only through these great possibilities that economic success would be reached.

In practical operation, the wind will affect the speed of the airship by the whole of its velocity, both in actual retardation and acceleration and in directions across the line of motion of the airship. Another difficulty will be the difficulty of finding the destination and effecting a landing in foggy weather. None of these drawbacks arises merely from imperfections in the present development of the airship, but they are inherent in any form of aerial vehicle, no matter how perfect.

There may be exceptional cases in which the airship will supply a more effective means for attaining an end than any other at our command, as for instance for reaching the Pole. She may also be of some value in warfare. Her possible usefulness in reconnaissance, though easily exaggerated, is obvious, but she can never be made an effective fighting machine or means of transportation. Her vulnerability, her great size, the impossibility of operating at night or in a fog and thus concealing her operations, the difficulty of navigating in a wind, all combine to make the idea of using the airship for invasion quite chimerical. If the airship is used at all for military operations it must be at such a height above the ground as to be outside the range of bullets or machine-gun projectiles, which can easily be fired directly upwards to a distance of at least two miles. The only rational fear is that airships may be able to drop explosive bombs into fortifications or upon the decks of warships. At a height of two miles the air is rarer by about one-fourth than at the earth's surface and this reduces in a still greater proportion the weight of projectiles the airship could possibly carry. Every ton of projectiles carried to a height of two miles would require more than 5,000 cubic yards of gas in the balloon and the task of seriously injuring a modern fortification by dropping explosives into it will be at least an expensive one. As for the danger to ships of war, the difficulty of striking a rapidly moving target with a projectile dropped from so unstable a platform as that of the airship renders it practically negligible.

SULPHUR DIOXIDE FOR FIGHTING MINE FIRES.

A STATEMENT OF ITS ADVANTAGES OVER THE COMMONLY USED CARBON DIOXIDE.

Walter O. Snelling—American Institute of Mining Engineers.

CARBON dioxide has been frequently used, and with considerable success, in combating mine fires by the production of an atmosphere incapable of supporting combustion. The gas for this purpose is produced by the reaction in large wooden boxes of sulphuric acid and limestone and it is led in large pipes to the location of the fire which is entirely closed off by tight brattices. Though simple and effective the method is expensive, and the high cost coupled with the risk of producing an explosion by the reduction (by the heated carbon) of the carbon dioxide to carbon monoxide has prevented its general application. Mr. Walter O. Snelling in a paper recently communicated to the American Institute of Mining Engineers suggests that a much more cheap and safe method may be found in using sulphur dioxide instead of carbon dioxide. We quote at length from this paper which is published in the *Bulletin* of the Institute for September.

"The use of sulphur dioxide in combating mine fires has not, I believe, been previously suggested or tried, and yet the method presents such decided advanmay be found in using sulphur dioxide that it seems proper to suggest the advisability of considering it as a cheap, convenient and safe means of fighting stubborn mine fires.

"One ton of brimstone, costing from $20 to $30, will produce about 25,000 cubic feet of sulphur dioxide gas, and allowing for all sources of loss it is probable that sulphur dioxide gas can be produced for about $1,300 per 1,000,000 cubic feet. For carbon dioxide gas, produced by the action of sulphuric acid on limestone, a good estimate would be $4,000 per 1,000,000 cubic feet, provided that sulphuric acid and limestone could be obtained at a small cost. Even under these favorable conditions it will be seen that carbon dioxide is about three times as costly as sulphur dioxide, and under ordinary conditions the advantages on the side of sulphur dioxide would be much more marked.

"Sulphur dioxide is more efficient than carbon dioxide in the putting out of fire. Neither coal nor any other combustible material can possibly burn in an atmosphere containing any considerable quantity of sulphur dioxide. Sulphur dioxide is very heavy, being almost twice as heavy as carbon dioxide (1 cubic foot weighing 81 grains, while 1 cubic foot of carbon dioxide weighs 56 grains). and this heavier weight of the sulphur dioxide is also an element which leads to increased efficiency, since the readiness with which the air present in the interstices of a pile of burning coal will be displaced by any inert gas is dependent upon the density of the gas, and as sulphur dioxide is twice as heavy as carbon dioxide, it will have about twice the efficiency of the lighter gas in displacing the air from piles of burning material, and thus removing the oxygen available for continuing the combustion. Another important effect of the greater density of sulphur dioxide is that its cooling effect upon a bed of incandescent coal is greater, volume for volume, than with a less dense gas.

"None of the dangers incident to the use of carbon dioxide is present with sulphur dioxide. No explosive lower oxides are produced or can be produced by the reduction of sulphur dioxide. Still more important, the danger always present when using carbon dioxide, of men getting into the gas without knowing of its presence, and suffocating, is absent when sulphur dioxide is used, since its strong odor gives instant warning when but a small fraction of 1 per cent of the gas is present in the air.

"Any leakage of carbon dioxide from a mine can only with great difficulty be detected. Frequently, in places where this method has been applied, it is probable that millions of cubic feet of the gas have escaped through unknown fissures in the rock. Any leakage of sul-

phur dioxide would quickly make itself known, and the openings could accordingly be closed before more than a small portion of the gas had escaped.

"The keeping of oxygen-helmets as emergency apparatus at coal and other mines is believed to be increasing in the United States, and it is to be most strongly advocated. When such oxygen apparatus is at hand it will nearly always be possible to send men from time to time to see if the mine-fire is extinguished before turning the ventilation into that portion of the mine. Most forms of rescue-masks can thus be worn in an atmosphere of sulphur dioxide, so it is possible to know definitely when the fire is extinguished, and when it is safe to turn in the fresh air. But when the sulphur dioxide method has not been used, the large amount of carbon monoxide present is likely to be a source of danger to the person wearing the helmet, since it is an interesting fact that some of the simpler patterns of rescue-helmets which may be worn with safety in an atmosphere of sulphur dioxide are found to be but little protection when worn in an atmosphere containing much carbon monoxide. The reason for this is not clear, but it is most probably due to the greater permeability to carbon monoxide of the leather or other fabric of which the rescue-mask is made, the lighter carbon monoxide passing through the fabric with greater readiness than most other gases.

"The extremely simple manner in which sulphur dioxide can be produced, the cheapness of the method, and the efficiency of the gas in putting out fires, seem to make this a desirable means of combating mine-fires. The safety of the method, its convenience, and its utility in showing fissures which allow escape of gas and ingress of air, are also strong points in its favor. The following comparison of the physical properties and cost of producing sulphur dioxide and carbon dioxide will be of interest.

	Sulphur Dioxide	Carbon Dioxide
Molecular mass.	64.	44.
Mass of 1 liter..	2.87 g.	1.97 g.
1 cu. ft. weighs.	81.13 g.	55.78 g.
1,000 cu. ft. weighs.....	178.48 lb.	122.71 lb.
1,000 cu. ft. requires.....	89.24 lb. sulphur.	300 lb. H_2SO_4, 296 lb. $CaCO_3$
Cost materials per 1,000 cu.ft.	$1.35	$4.00
Cost of 1,000,000 cu. ft.....	$1,350.00	$4,000.00

"In effectiveness, safety, and other considerations the advantages are also in favor of the sulphur dioxide."

RAILLESS ELECTRIC TRACTION.

A NOTE ON THE SUCCESSFUL SYSTEM LATELY INSTALLED AT MÜLHAUSEN, GERMANY.

F. Douglas Fox—British Association for the Advancement of Science.

IN the course of a long paper dealing exhaustively with the comparative economics of omnibuses and electric tramways for street transportation in towns of moderate size, read before the British Association for the Advancement of Science and printed in *Engineering* for September 18, Mr. F. Douglas Fox gives some interesting details of one of the latest installations in Europe of the railless electric traction system, that at Mülhausen, Germany. So successful has this project proved that it has been adopted as the model for a system about to be installed at Dundee, and Mr. Fox believes that when the pre-eminent suitability of the system to the solution of transportation problems under certain special conditions is more fully known, its use will be rapidly extended. We quote in its entirety this part of his paper.

"However much the electric omnibus, driven from accumulators, may yet be improved, the cost of the batteries added to that of the rubber tires, will in all probability limit its use to those circumstances where a fairly good revenue is to be obtained. The possibility is still a remote one of battery power being reduced in cost, and of some cheap substitute for rubber being found to reduce these items of working expense to a level with the cost of operating cars upon rails.

"Electricity has, however, in the method known as the 'trackless trolley system,' of operating road vehicles by overhead wires, entered the field of highway transportation with much more likelihood of favorable competition with both the tramway and with the light railway. The peculiar facility with which, by this system, both passenger and goods traffic can be handled over the same line, the latter not requiring the expense of rubber tires, renders this method probably the most economical system of highway transportation which has yet been devised.

"On the Continent of Europe numerous installations of electric road traction are in operation for the transportation of both goods and passengers, in which the driving current is obtained from aerial conductors, and taken by a swivelling contact-boom, having sufficient lateral freedom to enable the car to deviate in either direction sufficiently to pass other vehicles.

"These installations date from the year 1901, and each year sees not only fresh lines opened, but also installations of greater importance are being undertaken. Seven of these lines are in operation in Germany, one in France, and three in Italy. The Italian Government is said to have in contemplation the utilization of the public highways for this mode of transportation upon an extended scale.

"One of the latest of the projects, now well on the way to completion, is that of Mülhausen, in Alsace. The city, of 100,000 inhabitants, is already supplied with a tramway system, but it was found necessary to further connect the suburbs with these tramways, and also with one another. It is also desired to obtain better access to the Public Gardens during the summer months. The traffic was, however, estimated to be too light to render a tramway profitable. The corporation appointed a commission to report first as to whether any means of communication could be made remunerative, and secondly, as to what means to adopt.

"The complete scheme was to be for six and three-quarter miles of route, on which 550,000 car-miles were to be made per annum. The Commission reported on three alternative proposals:

1. For a very cheaply constructed tramway for which plans and specifications were prepared by their own engineer.

2. For a service of motor omnibuses operated by benzine engines, for which several tenders were made by manufacturers of these vehicles.

3. For a 'railless traction' line of electric omnibuses with aerial conductors.

"The line to the Public Gardens has gradients as steep as 1 in 12; the zone line is comparatively flat. The estimates were to include a fixed charge of 4 per cent. interest upon capital. The conclusions of the committee were, that the electric omnibus (trackless trolley system) was the only method having prospects of commercial success, and the installation was therefore contracted for, and is now under partial operation. The digest of the estimates is as follows:

—	Tramway	Benzine Omnibuses.	Electric Omnibuses with Aerial Conductors (Trackless Trolley System).
Total cost	62,530*l.*	23,581*l.*	25,050*l.*
Total cost per mile of route	9,260*l.*	3,500*l.*	3,700*l.*
Expenses per car-mile, including repairs, renewals, depreciation, and 4 per cent interest	7.30*d.*	9.45*d.*	5.13*d.*

"The benzine omnibuses and the electric vehicles were of about the same capacity; the tramcars would have given considerable more accommodation.

"The prices of labor for both construction and operation are lower in Germany than in England. The tariff is correspondingly low.

"The Mülhausen line is interesting, not only from being the longest yet undertaken upon this system, but also from the severity of the gradients. The corporation decided that the Public Garden line should precede the zone route, and

that the brake tests should be such that the braking of either axle independently should be sufficient to hold the car on the steepest gradient, and also to bring it to a standstill in the shortest possible time. Also, that these tests should be carried out in winter. The road is of macadam saturated with tar by a new German process, which attains a smoothness almost equal to that of asphalt, and much resembles 'tarmac.'

"The car is steered and driven on the front axle, the wheels of which are rubber-tired, the rear axle having steel tires; both axles are supplied with mechanical brakes, and the front axle with an electric brake. The car accelerates and maintains speed on the gradient of 1 in 12 without any trouble; the single forward brake-gear is sufficient for holding the car, but the braking of the tired wheels on the rear axle has required modification. During a recent visit paid to this installation by Mr. Bertram Douglas Fox, chief electrical assistant to the writer's firm, the car was put through all the tests required by the authorities, and the performances were satisfactory. This section of the line is now opened for traffic. On some of the lines in Germany goods transportation is being carried on upon the same lines as a passenger business without any inconvenience, the former being handled by trains of cars hauled by a double-ender electric locomotive, the cars being provided with a coupling and steering device which compels them to follow the exact course taken by the locomotive.

"Making all due allowance for cheap labor in Germany, there appears good ground for the view that this method brings electric transportation upon highways into a possible competition with any other method of handling traffic. At the figures of working expense estimated by the Mülhausen committee, such a system could pay its way in this country with the smallest revenue earned by any tramway in England, even allowing for the higher rate of wages here than in Germany.

"As to the respective fields for the electric omnibus with accumulators or with overhead wires, these may be defined by the question as to whether overhead wires are permissible, and also whether, in the former case, the traffic is sufficiently heavy to cover the extra cost of the batteries. The two systems may be viewed as complementary, because in many problems of urban transportation it may be found expedient to operate different sections of the same city on one or the other method. Taken together recent advances point to the probability that in this way electricity has entered upon the field of transport upon public highways, to do as much for it as it has done for transport upon railways."

THE PRE-COOLING OF PERISHABLE FREIGHT.

METHODS, ADVANTAGES AND POSSIBILITIES OF PRE-COOLING IN RAILWAY REFRIGERATION.

Dr. Joseph H. Hart—Railroad Age Gazette.

COMMENTING on the slow progress made in adapting mechanical refrigeration to railway transportation in THE ENGINEERING MAGAZINE for December, 1907, Dr. Joseph H. Hart mentioned the air-cooling system as the most efficient in use for certain classes of freight and as one of the few systems which offered reasonable assurance of success in further development. In the *Railroad Age Gazette* for September 4, the same author calls attention to the remarkably rapid extension of the system and gives an interesting discussion of its advantages and possibilities from which we quote at length below:

"The installation of pre-cooling plants for the preparation of fruit and vegetables before transportation is a phase in the application of refrigeration to the transportation business which is rapidly attaining unusual proportions. A number of interesting results in regard to the effect of pre-cooling and the absence of this feature in railway transportation have been fully set forth in a bulle-

tin in the process of publication by the Bureau of Plant Industry of the United States Department of Agriculture. Under best conditions for pre-cooling it takes from 18 to 24 hours to cool oranges or other fruit in bulk to a temperature at which decay is impossible, and even under these circumstances portions of the fruit are cooled considerably below the danger point at which freezing occurs. In the average shipment of oranges from California cooling occurs at such a slow rate with natural ice refrigeration that the oranges often arrive in New York before the pre-cooling stage is complete or the processes of decay stopped. Being then transferred to cold storage warehouses they receive during this process an increased impulse toward decay, augmented very greatly by the fact of their previous condition for a comparatively long period. The result is that their resistance to the ordinary processes of decay is much diminished, and even if maintained in cold storage they do not possess the quality obtainable from fruit placed immediately in cold storage, and this latter feature is especially noticeable in their keeping qualities. Thus both from the shipper's and consignee's end suitable refrigeration in transportation has become almost an absolute necessity, and this satisfactory refrigeration, at least for temporary conditions and conditions capable of alleviation, can be produced by the installation of suitable pre-cooling plants. Government experiment plants exist in California and the South and a number of railroads have erected plants of the pre-cooling type in both sections. The chief difficulty in this process of pre-cooling is the length of time which must elapse in order to accomplish this. Generally from 18 to 24 hours is required to cool oranges or other fruit in bulk to a temperature at which decay is impossible, and even under these circumstances the refrigeration is unsatisfactory owing to abnormally low temperatures in certain sections. Wherever installed, however, these plants will undoubtedly prove a commercial success not only on account of the saving in shipments due to diminution in decay and the better quality of the shipment after transit, but on account of a larger number of other factors which enter as well in limiting the efficiency of the transportation process.

"Thus, pre-cooled fruit requires less ice for its transportation, since the sole duty of the ice under these circumstances is to maintain an initial temperature. It is even advocated that pre-cooling be used during the period when ventilation is the prevailing method and icing is not necessary. With pre-cooled fruit, packing can be much closer and ventilation is not nearly as necessary and need not be as thorough. Thus, oranges have been recently shipped to New York City in car lots of from 549 to 584 boxes each, an increase of more than 40 per cent over the standard car of 384 boxes. This increase in capacity is due not only to closer packing, but higher packing as well. In many refrigerator cars during the icing period it is impossible to fill the car on the top tiers without very considerable loss due to the fact that the temperature is much higher at all times in the top of the car than in the bottom. With pre-cooling and ventilation only the average rise in temperature at the top of the car is from 8 to 10 degrees and at the bottom about half of this. Even with this rise in temperature the average temperature of the fruit on arrival is usually lower than it is in cars under standard icing and the same conditions of weather and temperature.

"Pre-cooling plants consist of several distinct types, the car cooling unit and the package cooling type. In the former the cars are packed for shipment in the ordinary way and run on tracks into a refrigerating apartment, where they are cooled in a number of ways. The United Fruit Company has a number of interesting plants of the former type for the refrigeration of bananas during transportation, and by utilizing pre-cooling plants has been able to eliminate refrigeration in transportation entirely. Bananas, however, represent a comparatively easy phase of the problem for solution, maintaining their condition best at a temperature of from 55 to 65 degrees. However, this is from a refrig-

erating capacity viewpoint alone, since they are a very delicate fruit which when once ripe cannot be prevented from decaying and for this reason are always cut green and shipped to this country. A large proportion of this fruit is landed in New Orleans and shipped all over the country and takes from eight to ten days to deliver it in various sections. A typical plant at Springfield, Mo., consists of a train shed with four lines of track capable of cooling 10 cars each. A large refrigerating machine cools off, by means of brine circulation, large quantities of air which are conducted by overhead troughs along the top of the cars and connected by canvas chutes to the various ventilator openings. By this method of air cooling the cars can be reduced from about 75 degrees to 60 degrees in 12 hours. They can travel for about two or three days before the temperature rises to the danger point again. In Los Angeles a somewhat similar plant exists for the precooling of oranges in car lots. The Southern Pacific and Santa Fé Railroads in this section have developed a number of types of pre-cooling plants and private interests have entered the field, and there are government experimental plants in this section and in the South as well. An ordinary cold storage plant is in reality a pre-cooling plant of one type; it employs the package system. The freight or commodity should be installed in the cold storage plant house two or three days before shipment, but this involves the handling of the material twice and a considerable loss on this account. The train or car system of pre-cooling is undoubtedly superior from an efficiency point of view, although it requires a slightly longer time for the production of the required temperature. The chief difficulty in the precooling plant is due, from an economic viewpoint, to the fact that its duty is essentially temporary and that it must have a large capacity due to various overloads at certain times. Thus one railroad system was recently compelled, in California, to ship in about 20,000 tons of ice to take care of about 20 per cent additional of the citron industry, the shippers of which had decided to use icing instead of ventilation. This represents the chief phase of the difficulty from the railroad viewpoint, the variability of the demand and the character of it at the option of the shipper. Under these circumstances satisfactory results can be attained only by municipal endeavor. A very large number of the smaller communities throughout the southern states have their own ice-making plant and cold storage warehouse and the installation of a pre-cooling addition to this represents a phase for legitimate progress. Again, it is undoubtedly a function of such communities to see that the terminal facilities are adequate to meet the demand, since in some respects it seems entirely outside the province of railroad work, or at least beyond the satisfactory solution by them under present economic conditions. The fact that in some localities more especially favorable the railroads have gone ahead in the installations of such plants is additional warrant for their good faith in this business and their attempt to install satisfactory working conditions. One of the chief difficulties at present arising from the outcry against the railroads in regard to discrimination on account of car shortage and terminal facilities has resulted in an attempt to give all parties equal service with the result that none is satisfactory and the general car movement has been much reduced due to readjustment at division points with this object in view.

"That the problem to the railroad is an essential one is without question. Not only cannot the demand for refrigeration be accurately foretold from crop conditions, but immediate weather conditions enter as well. The requirement for railroad refrigeration is for an extremely mobile and transportable refrigerating plant embodying all the increased efficiency of the mechanical refrigeration system in the production of the icing and one capable of operating in large units and under what are often regarded as inadequate conditions by the refrigerating engineer. Results can only be attained by the co-operation of the various communities among themselves and in conjunction with the various railroads involved in the problem as well."

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Bascule.

A Remarkable Bascule Bridge at Syracuse, N. Y. Illustrates and describes a trunnion bascule bridge of 44 ft. span over the Oswego canal, located on a sharp skew. 3500 w. Eng News—Sept. 24, 1908. No. 95360.

Blackwell's Island.

The Construction of the Manhattan Approach of the Blackwell's Island Bridge. Illustrated detailed description. 2500 w. Eng Rec—Sept. 5, 1908. No. 94868.

Cables.

See Manhattan, under BRIDGES.

Concrete.

Data on 32 Concrete and Reinforced Concrete Bridges (20 Highway and 12 Railway), Including Yardage, Cost, Etc. Gives detailed records of material, cost, etc. 5500 w. Engng-Con—Sept. 2, 1908. No. 94859.

Culverts.

See Sewers, under MUNICIPAL.

Manhattan.

The Cables of the New Manhattan Bridge. H. R. Cobleigh. Illustrated description of the manner of stringing the wires of the supporting cables. 1500 w. Ir Age—Sept. 17, 1908. No. 95203.

We supply copies of these articles. See page 326.

Masonry.

The Design of Many-Span Masonry Arch Bridges (Calcul des Ponts en Maçonnerie à Plusieurs Arches). Henry Lossier. Describes the simplest method. Ills. 6000 w. Génie Civil—Aug. 15, 1908. No. 95114 D.

A Three-Hinged Masonry Arch with Metal Joints and Concrete Superstructure. M. Henri Tavernier, in *Ann. des Ponts et Chaus.* Illustrated description of an arch bridge near Lyons, France. 1000 w. Eng News—Sept. 10, 1908. No. 95010.

Piers.

Repairing the Concrete Pier of a Bridge by Injection of Liquid Cement Mortar. Trans. from *Génie Civil.* Describes methods used on a bridge over the Kiel Canal. 1000 w. Sci Am—Sept. 26, 1908. No. 95335.

Reinforced Concrete.

Light and Heavy Bridges (Ponts Lourds et Ponts Légers). A. Pendariés. Illustrated detailed description of a remarkably light, strong and cheap reinforced-concrete bridge over the Canal du Midi at Toulouse. 10000 w. Rev de Métal—Aug., 1908. No. 95104 E + F.

See also Concrete, under BRIDGES.

Removal.

Removing the Madison Avenue Bridge, New York. An account of the removal of a drawbridge and erection on temporary site to carry traffic during the construction of a new bridge on the old site. Ills. 1200 w. Eng Rec—Sept. 19, 1908. No. 95231.

Steel.

The Life of a Modern Steel Bridge. Editorial on means of lengthening their life. 1200 w. Eng Rec—Sept. 19, 1908. No. 95225.

Some Historic British Bridges. Illustrates and describes several large bridges of engineering interest and their construction. 3000 w. Eng News—Sept. 17, 1908. No. 95220.

Flood-Resisting Bridge Construction in the Western United States. H. A. Crafts. Illustrated descriptions of special bridge design and erection for California mountain streams. 800 w. Cassier's Mag—Sept., 1908. No. 94735 B.

The Reconstruction of the Central Spans of the Colesberg Bridge, Cape Colony. Illustrated description of the erection of new girders for three spans of this bridge in South Africa. 1500 w. Engng—Aug. 28, 1908. No. 94949 A.

See also Ganges, under WATERWAYS AND HARBORS.

Viaducts.

The Erection of the Sawyer's Canyon Viaduct. Illustrated description of methods used for a steel viaduct of 286 feet extreme height, in Idaho. 2000 w. Eng Rec—Sept. 26, 1908. No. 95382.

CONSTRUCTION.

Amusement Devices.

The "Flip-Flap." Illustrated description of an amusement device at the Franco-British exposition. 1200 w. Sci Am—Sept. 19, 1908. No. 95238.

Beams.

Notes on the Behavior of Beams. E. H. Fish. Compares actual results and theory. 2500 w. Am Mach—Vol. 31. No. 39. No. 95328.

Bins.

Methods and Cost of Constructing Concrete Silos. Information of value. 2000 w. Engng-Con—Sept. 9, 1908. No. 94998.

Building Removal.

Moving a Large Brick Factory Building. Illustrates and describes the methods used in moving a 5-story brick building in Chicago. 1800 w. Eng Rec—Sept. 19, 1908. No. 95227.

Campanile.

The Rebuilding of the Campanile of St. Mark's at Venice. Describes the original structure, its fall, and reconstruction now in progress. Ills. 1800 w. Eng News—Sept. 24, 1908. No. 95358.

Concrete.

See Roads, under MUNICIPAL.

Concrete Blocks.

See Sewers, under MUNICIPAL.

Demolition.

The Removal of the Trainshed of the Grand Central Station, New York. An illustrated account of methods used in demolishing this large shed while in full service. 4000 w. Eng Rec—Sept. 19, 1908. No. 95230.

Excavation.

See Panama Canal, under WATERWAYS AND HARBORS.

Failures.

Failure of a Water Tank Tower. W. H. Kellogg, Jr. An account of an accident to a steel tank at Grand Rapids, Mich. 800 w. Eng News—Sept. 24, 1908. No. 95366.

Floors.

A Study of the Elasticity and Resistance of Reinforced Concrete Floors on the Siegwart System (Studio del Comportamenta Elastico e delle Condizioni di Resistenza di un Solaio in Cemento Armato Constituito di Travi Tubolari Tipo Siegwart). Carlo Parvopassu. Mathematical. Ills. Serial. 1st part. 6000 w. Ann d Soc d Ing e d Arch Ital—July 15, 1908. No. 95119 F.

Foundations.

The Substructure of the Pope Building, Cleveland, Ohio. Illustrated description of the use of steel sheet pile cofferdams in constructing the foundations for a 10-story steel frame structure. 3500 w. Eng Rec—Sept. 26, 1908. No. 95380.

We supply copies of these articles. See page 326.

Reclamation.

The Reclamation of an Empire from the Swamps. George Ethelbert Walsh. Considers the vast areas of land in the United States available by drainage. 3000 w. Cassier's Mag—Sept., 1908. No. 94740 B.

Reclaiming Newark Meadows. Discusses the most economical method of reclaiming land in New Jersey, as reported by the commission appointed. Ills. 2000 w. Munic Jour & Engr—Sept. 16, 1908. No. 95083.

Records.

The Importance of Records in Engineering Work. E. E. Howard. Abstract of a paper in the Nebraska Blue Print, 1908. Emphasizes the importance of record making in general, and the characteristics records must possess to be valuable. 4000 w. Engng-Con—Aug. 26, 1908. No. 94707.

Reinforced Concrete.

Reinforced Concrete. J. Monash. Considers present practice in design and construction. 2500 w. Archt, Lond—Sept. 4, 1908. No. 95028 A.

Diagrams for Use in Designing Reinforced Concrete T-Beams. J. Nolman Jensen. Diagrams and explanations of their derivation. 600 w. Eng Rec—Sept. 19, 1908. No. 95228.

Expanded Metal for Reinforced Concrete Work. Ernest McCullough. Explains the advantages of expanded metal for reinforcement. 1200 w. Min Wld—Sept. 5, 1908. No. 94889.

Reinforced Concrete Farm Buildings. J. P. H Perry. Illustrated description of a group of farm buildings near Sterlington, N. Y. 2000 w. Cement Age—Sept., 1908. No. 95063.

The Torrey Buildings, Boston, Mass. Illustrated description of reinforced-concrete factory buildings. 1800 w. Eng Rec—Sept. 19, 1908. No. 95229.

A new Application of Reinforced Concrete for Structures in Contact with Water. (Una Nuova Applicazione del Cemento Armato per le Costruzioni in Contatto coll' Acqua). A description of the Sanders System. Ills. Serial. 1st part. 2700 w. Il Cemento—July, 1908. No. 95123 D.

The Reinforced-Concrete Construction in the Markus Church, Stuttgart (Die Eisenbeton-Konstruktionen der Markuskirche in Stuttgart.) S. Zipkes. The first part illustrates and describes the tower. Serial. 1st part. 2000 w. Deutsche Bau—Aug. 19, 1908. No. 95144 D.

See also Bins, Floors and Stacks, under CONSTRUCTION; and Shipbuilding, under MARINE AND NAVAL ENGINEERING.

Stacks.

Wind Stresses in Reinforced-Concrete Chimneys, and a Diagram for Their Determination. E. R. Maurer. Considers two cases, explaining method used. 2200 w. Eng News—Sept. 10, 1908. No. 95009.

Steel Buildings.

Rational Ironwork for Store and Loft Building. George B. Ford. Illustrates and describes types of buildings using structural steel. 1500 w. Am Archt—Sept. 16, 1908. No. 95081.

The Erection of the Waverly Warehouse. Illustrated description of the erection of the Carnegie Steel Co.'s storage plant, near Newark, N. J. 2000 w. Eng Rec—Sept. 26, 1908. No. 95378.

The Hartford Armory Drill Shed. Illustrated description of framework for a structure 270 feet long, 187 feet wide, and 108 feet high. 1000 w. Eng Rec—Sept. 12, 1908. No. 94967.

See also Construction, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Tunnels.

Work on the Tunnel Under Washington Street. Edward S. Sears. Considers novel problems encountered in the construction of this Boston tunnel. Ills. 1500 w. Public Works—July-Sept., 1908. No 95320 B.

The Waterproofing of the Land Sections of the Detroit River Tunnel. Stacey H. Opdyke. Describes this work and also details of construction. Ills. 2500 w. Eng News—Sept. 24, 1908. No. 95362.

The Construction Plant and Methods Employed on the Approaches of the Detroit River Tunnel. Illustrates and describes important work in connection with improvements to eliminate the car ferry. 6500 w. Eng Rec—Sept. 19, 1908. No. 95226.

Waterproofing.

See Tunnels, under CONSTRUCTION.

Wind Bracing.

Wind Bracing with Knee Braces or Gusset Plates. A. C. Wilson. Aims to determine the stresses in the main members of a bent made of columns and girders, with the diagonals omitted. 3000 w. Eng Rec—Sept. 5, 1908. No. 94871.

MATERIALS OF CONSTRUCTION.

Brick.

How Sand-Lime Brick Should be Made. J. H. Van Glahn. Discusses practical methods, giving the best results. 1500 w. Ind Wld—Sept. 7, 1908. No. 94851.

Cement.

The Theory of the Binding and Hardening of Portland and Roman Cement. (Zur Abbindungs- und Erhärtungstheorie der Portland und Romanzemente.) F.

We supply copies of these articles. See page 326.

Janda. 3200 w. Oest Zeitschr f Berg u Hüttenwesen—Aug. 22, 1908. No. 95139 D.

The Testing and Properties of Hydraulic Cements. (Gli Assaggi e le Proprietà degli Agglomeranti Idraulici). The first part discusses the testing of Portland cement for homogeneity and fineness. Ills. Serial. 1st part. 3500 w. Il Cemento—July, 1908. No. 95124 D.

Paints.

Notes on Specifications for Painters' Work. Arthur Seymour Jennings. Considers the materials and paints in general use, giving a number of tests for determining their quality. 4500 w. Public Works—July-Sept., 1908. No. 95298 B.

The Inhibitive Power of Certain Pigments in the Corrosion of Iron and Steel. Allerton S. Cushman. Read before the Am. Soc. for Test. Materials. A report of tests made and their results. 1800 w. Eng Rec—Sept. 19, 1908. No. 95233.

Timber.

Spontaneous Ignition of Wood. Frank R. Fairweather. Discusses the effect on wood of long continued heating. 1000 w. Ins Engng—Sept., 1908. No. 95407 C.

The Hard Woods of Eastern Australia. Gives a graphical diagram showing results of Government tests, with notes. 700 w. Engr, Lond—Aug. 21, 1908. No. 94787 A.

Our Timber Supplies. A. D. Webster. Discusses the conditions in Great Britain principally, and the most feasible way to overcome the difficulty. 2000 w. Contemporary Review—Sept., 1908. No. 95075 D.

The World's Timber Supply. Discusses the supply, especially of the United Kingdom, Canada and New Zealand; the waste and need of Government action. 3500 w. Builder—Sept. 5, 1908. No. 95026 A.

MEASUREMENT.

Stream Flow.

Water Measurement (Wassermessung). A. Linker. Discusses theoretically and practically the methods of measuring stream discharge. Ills. 2500 w. Die Turbine—Aug. 5, 1908. No. 95148 D.

Surveying.

Stadia Surveys for the Location of the Catskill Aqueduct, Peekskill Division. Boris Levitt. Describes the method used. Ills. 2000 w. Eng News—Sept. 3, 1908. No. 94863.

Precise Level Operations on the Los Angeles Aqueduct. Charles H. Lee. Illustrates and describes methods used in running 525 miles of single-line levels, and establishing 136 permanent bench marks. 2500 w. Eng News—Sept. 17, 1908. No. 95224.

The Two-Instrument Method of Compass Adjustment. (Magnetorientierung mit zwei Orientierungsinstrumenten). Fl. Lederer. Mathematical demonstration. Ills. Serial. 1st part. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—Aug. 22, 1908. No. 95138 D.

MUNICIPAL.

Gosport, Eng.

Gosport Public Works. H. Frost. Paper read before the Inst. of Munic & Co. Engrs. Outlines the history of this place and describes the more important public works. Ills. 7000 w. Surveyor—Aug. 28, 1908. Serial. 1st part. No. 94927 A.

Johannesburg.

Valedictory Address by the President of the South African Association of Engineers. G. S. Burt Andrews. The subject is municipal work in Johannesburg. Giving a brief description of some of the more important works. 11500 w. Jour S African Asso of Engrs—July, 1908. No. 94761 F.

Roads.

The History of Roads (Zur Geschichte der Landstrassen). Herr Layritz. Gives a brief review of the history of road making and discusses present practice. 3600 w. Zeitschr d Mit Motorwagen Ver—Aug. 31, 1908. No. 95161 D.

Effect of Motors on Macadam Roads. Logan Waller. Page address before the Good Roads Convention. Studies the effect of the shearing force of motor cars. 1700 w. Eng Rec—Sept. 26, 1908. No. 95379.

Dust-Laying and Permanent Surfacing. M. H. West. Gives results of recent experiments on roads in Chicago parks. 2500 w. Munic Jour & Engr—Sept. 16, 1908. No. 95084.

Dust Preventives. Prevost Hubbard. Considers the causes of dust on highways, indicating the measures that have been taken to solve the problem of dust prevention and road preservation. Ills. 24500 w. U S Dept of Agri, Bul No. 34—Sept. 22, 1908. No. 95323 N.

Concerning Roads, English and American. A Contrast and Its Explanation. Considers horse-shoe calks largely the cause of the difference. 3000 w. Eng News—Sept. 24, 1908. No. 95363.

Method and Cost of Repairing Macadam Roads by Scarifying Instead of by Patching. E. A. Hackett. The paper gives methods used in Ireland. 3000 w. Engng Con—Sept. 2, 1908. No. 94855.

A Nine-Mile Concrete Road for Automobiles. Illustrated description of the Long Island Motor Parkway. 2500 w. Eng Rec—Sept. 26, 1908. No. 95375.

Septic Tanks.

Domestic Septic Tanks. Herbert F.

We supply copies of these articles. See page 326.

Shade. Gives the writer's views as to the best system of sewage disposal for isolated houses. 1500 w. Dom Engng—Sept. 12, 1908. No. 95012.

Sewage Disposal.

Royal Commission on Sewage Disposal. Gives conclusions and general summary of the fifth report, just issued. 3500 w. Engng—Sept. 11, 1908. Serial. 1st part. No. 95090 A.

Recent Tendercies in Sewage-Disposal Practice. C. E. A. Winslow and Earle B. Phelps. Considers latest experiments, comparing with the conditions in America and Germany. 3500 w. Public Works—July-Sept., 1908. No. 95317 B.

Some Recent Experiments on the Biolysis of Sewage. W. D. Scott-Moncrieff. A report of experiments made to discover the periods of hydrolysis that gave the necessary purification, and if filtration would yield the required purification. Also discussion. 3500 w. Surveyor—Aug. 21, 1908. No. 94762 A.

Sewers.

Reinforced Concrete Block Construction for Culverts and Sewers. Gives two forms of block construction which have been developed with unusual care. 1500 w. Engng Con—Sept. 2, 1908. No. 94856.

The Construction of the Osnabrück Reinforced-Concrete Sewer and the Damage Caused by Swamp Waters Containing Oxide of Sulphur. (Der Bau des Abwasser-Sammelkanales in Osnabrück und die an demselben beobachteten Zerstörungs-Erscheinungen durch Einwirkung schwefelsauren Moor- bezu. Grundwassers). Friedrich Lehmann. Ills. Serial. 1st part. 2200 w. Deutsche Bau—Aug. 22, 1908. No. 95145 D.

Smoke Prevention.

The Service of a Well Organized City Smoke Department. Robert H. Kuss. Outlines the work the smoke department should undertake, the proper supervision, etc. 4500 w. Ind Wld—Sept. 21, 1908. No. 95080.

WATER SUPPLY.

Analysis.

Methods of Water Analysis. J. H. Brewster. From a paper before the Indiana San. & Water Supply Assn. Presents a scheme for a uniform system throughout the State of Indiana. 2800 w. Munic Engng—Sept., 1908. No. 94727 C.

Conduits.

The Big Cottonwood Water Works Conduit of Salt Lake City, Utah. An illustrated description abstracted from the report of L. C. Kelsey. 1000 w. Munic Engng—Sept., 1908. No. 94726 C.

Dams.

Progress on the Roosevelt Dam, Salt River Project, U. S. Reclamation Service. Chester Wason Smith. A general review from the inception until the present summer. Ills. 2500 w. Eng News—Sept. 10, 1908. No. 95005.

The Mari-Kanavè Dam in Southern India. Illustrated description of a recently completed rubble masonry dam, constructed by native labor, in connection with an important irrigation scheme. 1200 w. Sci Am—Sept. 5, 1908. No. 94900.

Filtration.

A Short Account of the Lawrence Filter Beds. Arthur D. Marble. 3000 w. Jour Assn of Engng Socs—Aug., 1908. No. 95103 C.

The Pittsburg Filtration Plant. H. M. Leh and E. A. Foster. Illustrated description of a plant in which cement was an important factor. 1500 w. Cement Age—Sept., 1908. No. 95064.

The Use of Recording Gauges in a Filtration Plant. F. B. Leopold. Gives typical charts, explaining their indications and use. 2000 w. Eng Rec—Sept. 19, 1908. No. 95234.

Ground Waters.

The Variations in Ground Water Level in Munich. (Die Schwankungen der Grundwasserstände in München). Chr. Mezger. Curves. 7700 w. Gesundheits-Ing—Aug. 8, 1908. No. 95151 D.

The Variations in Ground Water Level and the Flow of Springs (Die Schwankungen der Grundwasserstände und der Quellenausflüsse). Chr. Metzger. A record of extensive observations. Ills. 8800 w. Gesundheits-Ing—Aug. 8, 1908. No. 95150 D.

Hydrological Investigations for the Third Water Works for Leipzig. A. Thiem and Dr. Tugr. G. Thiem, in *Jour. für Gasbeleuchtung und Wasserversorgung.* Describes a method of determining the capacity of underground water basins. 1200 w. Eng Rec—Sept. 26, 1908. No. 95383.

Irrigation.

Depth of Water in Irrigation Canals. C. E. Grunsky. Comments on types of irrigation canals and related matters, advocating the broad shallow type when not prohibited by conditions. 5000 w. Eng News—Sept. 10, 1908. No. 95011.

See also Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Piping.

Diagrams for Spacing Bands on Wood-Stave Pipe. Diagram, with explanation of its use. 500 w. Eng News—Sept. 3, 1908. No. 94865.

Purification.

Purification of Drinking Water from Manganese by Means of Aluminium Silicate. (Reinigung des Trinkwassers von

Mangan durch Aluminatsilikate). Dr. H. Noll. Reports tests on the process. 7000 w. Gesundheits-Ing—Aug. 22, 1908. No. 95152 D.

Water Supply Plant of the Walsum Cellulose Works (Wasserversorgungsanlage der Zellstoff-Fabrik in Walsum am Niederrhein). Herr Berkenkamp. Illustrated description of pumping and purification plants for large paper works. 2800 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 1908. No. 95183 D.

Typhoid.

Laboratory Tests of the Effect of Storage on the Vitality of the Typhoid Bacillus in the London Water Supply. A Contribution to the data on the beneficial effect of storage upon the sanitary quality of water, from a report by Dr. A. C. Houston. 600 w. Eng News—Sept. 3, 1908. No. 94862.

Water Works.

New Water Works at Selby. Illustrated detailed description of the new works, pumping engines, etc. 2800 w. Engr, Lond—Aug. 28, 1908. No. 94955 A.

Weir Discharge.

d'Ocagne's Method of Isoplethe Points Applied to the Francis Weir Formula. Richard Muller. An explanation of the principle and its application. 500 w. Eng News—Sept. 3, 1908. No. 94864.

WATERWAYS AND HARBORS.

Barge Canal.

The Barge Canal of the State of New York. David A. Watt. A brief description of this important engineering work, with history of the causes which led to its construction. Ills. and plate. 3000 w. Engng—Sept. 11, 1908. No. 95085 A.

Canals.

See U. S. Waterways, under WATERWAYS AND HARBORS.

Colorado River.

Changes in Bed and Discharge Capacity of the Colorado River at Yuma, Ariz. E. C. Murphy. Reports a study made to determine the cause of the apparent increase in the flow since 1903. 1800 w. Eng News—Sept. 24, 1908. No. 95365.

Docks.

The Methil Docks. Illustrated description of preliminary work in progress in preparation for harbor extension. 800 w. Engng—Sept. 4, 1908. No. 95052 A.

The New Ore and Coal Handling Dock of the Pennsylvania Company at Ashtabula Harbor, Ohio. Illustrated description of extensive terminal improvements. 6000 w. Eng Rec—Sept. 12, 1908. No. 94966.

Drydocks.

Modern Improvements in Dry Dock Construction. H. A. Crafts. Describes improvements in the handling of bilge blocks, method of drainage, cleaning the gate seats, etc. 500 w. Sci Am—Sept. 12, 1908. No. 94994.

A Floating Dock for Callao. Illustrated description of a dock of the double-sided, self-docking type. 800 w. Engr, Lond—Aug. 28, 1908. No. 94956 A.

Floating Dock for the Imperial Navy Yard at Wilhelmshaven (Schwimmdock für die Kaiserliche Werft in Wilhelmshafen). Herr von Klitzing. Illustrated detailed description. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 8, 1908. No. 95178 D.

Ganges.

The Narrowing of the Ganges and Construction of the Curzon Bridge. Illustrated description of interesting construction work in India. 1700 w. Sci Am—Sept. 26, 1908. No. 95336.

Glasgow.

Glasgow Harbor Extensions. Plan, illustrations and description of the new basins and quays at Yorkhill. 3000 w. Engr, Lond—Sept. 4, 1908. No. 95054 A.

Harbors.

See Glasgow, Philadelphia, Talcahuano, and Whitby, under WATERWAYS AND HARBORS.

Lake Michigan.

Currents in Lake Michigan. W. V. Judson. Read before the Lake Mich. Water Com. States the agencies which may produce currents, examining each. 2000 w. Eng Rec—Sept. 26, 1908. No. 95376.

Mississippi River.

Point Beka Crevasse, Mississippi River, Right Bank, Parish of Orleans, Louisiana. Frank M. Kerr. An illustrated account of the break and the attempts to close it, describing the construction. 2500 w. Jour Assn of Engng Socs—Aug., 1908. No. 95402 C.

Niger.

Navigation on the Niger (Le Service de la Navigation sur le Niger). Paul Privat-Deschanel. Discusses the navigability of the river, the type of boat in use, and the traffic handled. Ills. 4000 w. Génie Civil—Aug. 22, 1908. No. 95117 D.

Panama Canal.

Some Features of the Dry Excavation at Panama. An illustrated account of work in the Culebra Cut. 6500 w. Eng Rec—Sept. 5, 1908. No. 94867.

Philadelphia.

Philadelphia Harbor's Needs. A statement of conditions as they exist in Europe, with suggestions that might be followed, as given in the report of Joseph F. Hasskarl. 3500 w. Marine Rev—Sept. 10, 1908. No. 94965.

Piers.

Lackawanna Freight Pier No. 7, at Hoboken. A pier having a width of 100 ft. and a total length of 600 ft., with a one-story fireproof shed and other inter-

esting features. 4000 w. Eng Rec—Sept. 12, 1908. No. 94969.

Talcahuano, Chili.

The Harbor Works at Talcahuano, Chili (Die Havenwerken van Talcahuano, Chili). W. C. van Manen. Illustrated description of the docks, etc. 9750 w. De Ingenieur—Aug. 27, 1908. No. 95196 D.

Tiber.

Rome and the Sea (Roma ed il Mare). Paolo Orlando. A general discussion of the possibility of making Rome an important port by improving the navigation of the Tiber. 4500 w. Ann d Soc d Ing e d Arch Ital—July 1, 1908. No. 95118 F.

U. S. Waterways.

The Anthracite - Tidewater Canals. Chester Lloyd Jones. Reviews their history, summarizing the conditions which determine whether or not they may again become available. 7000 w. R R Age Gaz —Sept. 4, 1908. No. 94885.

Water Powers.

The Conservation and Use of Water-Power Resources. H. von Schon. This second article examines the influence of conservation on industrial development. 3500 w. Engineering Magazine—Oct., 1908. No. 95309 B.

Whitby.

Whitby Harbor Improvement Works. Outlines the scheme of improvement at the mouth of the River Esk. Ills. 1200 w. Engr, Lond—Sept. 4, 1908. No. 95056 A.

MISCELLANY.

Japan.

Some Notes on Japanese Engineering. James D. Schuyler. Illustrated descriptions of interesting things observed during recent travels. 1600 w. Eng Rec—Sept. 26, 1908. No. 95374.

Stone Sawing.

Sawing a Building in Two. Illustrated description of methods used in sawing the façade and foundations of a four-story building in Paris. 1400 w. Sci Am—Sept. 26, 1908. No. 95337.

ELECTRICAL ENGINEERING

COMMUNICATION.

Condensers.

The Variation of Apparent Capacity of a Condenser with the Time of Discharge and the Variation of Capacity with Frequency in Alternating Current Measurements. B. V. Hill, in *Phys. Rev.* Describes tests and apparatus used. 1500 w. Electn, Lond—Aug. 21, 1908. No. 94770 A.

Electrical Vision.

Electrical Vision at a Distance. A. Troller. Illustrated explanation of the Armengaud system. 1000 w. Sci Am Sup—Sept 19, 1908. No. 95240.

Radio-Telegraphy.

On the Advantage of a High Spark Frequency in Radiotelegraphy. L. W. Austin. Gives results of investigations. 1000 w. Bul Bureau of Stand—Aug., 1908. No. 95387 N.

Propagation of Electric Waves in Wireless Telegraphy. James E. Ives. An attempt to give a physical explanation of the throwing off of electrical energy into space by a wireless antenna. 1700 w. Elec Wld—Sept. 26, 1908. No. 95332.

Electric Wave Detectors in Radiotelegraphy. Dr. J. A. Fleming. Describes the latest devices for receiving messages through space, and discusses related questions. Ills. 3000 w. Cassier's Mag—Sept., 1908. No. 94738 B.

Radio-Telephony.

The Collins System of Long Distance Wireless Telephony. Illustrated detailed description, with report of tests. 1400 w. Sci Am—Sept. 19, 1908. No. 95236.

Telephone Cables.

Methods of Locating Transpositions of Wires and Split Pairs in Telephone and Telegraph Cables. Henry W. Fisher. Shows how faults of this kind can be readily located by some methods devised by the author. 2000 w. Pro Am Inst of Elec Engrs—Sept., 1908. No. 94731 D.

Telephotography.

The Korn System of Image Transmission. C. S. Durand. Illustrated detailed description of the new apparatus and its use. 3500 w. Elec Rev, N Y—Sept. 5, 1908. No. 94860.

DISTRIBUTION.

Fuses.

Repaired Fuse Plugs (Repartierte Schmelzstöpsel). W. Klement and Paul H. Perls. Reports tests on repaired enclosed fuses showing that repairs are usually of no value. Ills. 3000 w. Elektrotech Zeitschr—Aug. 27, 1908. No. 95193 D.

Protective Devices.

New High-Tension Protective Devices of the Allgemeinen Elektricitäts-Gesellschaft (Neue geschlossene Hochspannungssicherungen der Allgemeinen Elektricitäts-Gesellschaft). W. Fellenberg. Illustrated description of various types and results of tests. Serial. 1st part. 2000 w. Elektrotech Zeischr—Jan. 16, 1908. No. 95302 D.

Switches.

See Insulating Oils, under MISCELLANY.

Wiring.

A Heavy-Conductor, Open-Work Installation. Arthur Gillman. Illustrates

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and describes details of construction. 2000 w. Elec Wld—Sept. 19, 1908. No. 95219.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Continuous Free Hunting in the A. C. Dynamos (Ueber dauernde freie Pendelungen bei Wechselstrommaschinen). Karl Willy Wagner. Mathematical discussion. Ills. 1800 w. Elektrotech u Maschinenbau—Aug. 9, 1908. No. 95172 D.

Current Displacement in Armature Slots (Einseitige Stromverdrängung in Ankernuten). Fritz Emde. Mathematical. Ills. Serial. 1st part. 2500 w. Elektrotech u Maschinenbau—Aug. 16, 1908. No. 95173 D.

A. C. Motors.

The Classification of Single-Phase Motors (Die Klassifikation der Einphasen Motoren). J. Jonas. Proposes a new and simple system. Ills. 2000 w. Elektrotech Zeitschr—Feb. 27, 1908. No. 95313 D.

The Form of the Characteristic Curves of Three-Phase Motors and the Separation of the Losses (Die Kurvenformen der Ströme in Drehstrom-Motoren und die Trennung der Verluste). K. Simons and K. Vollmer. An oscillographic study. Ills. 2800 w. Elektrotech Zeitschr—Jan. 30, 1908. Uo. 95307 D.

Acyclic Dynamos.

Acyclic Dynamos. C. Feldmann. Illustrates and describes the main features in the design of the actual machines. 1800 w. Electn, Lond—Aug. 21, 1908. No. 94769 A.

Acyclic Generators. J. E. Noeggerath. An illustrated article on their mechanical design and notes on operation. Also editorial. 2500 w. Elec Wld—Sept. 12, 1908. No. 95014.

Breakdowns.

Breakdowns of Electrical Machinery. Michael Longridge. From the annual report of the British Engine, Boiler and Electrical Insurance Co. Information concerning accidents during 1907. 5500 w. Mech Wld—Aug. 28, 1908. No. 94932 A.

Commutation.

The Fundamentals of the Commutation Problem (Grundlagen des Kommutierungs Problems). Reinhold Rüdenberg. Mathematical. Ills. 4800 w. Elektrotech Zeitschr—Jan. 23, 1908. No. 95304 D.

Construction.

Modern Motor Building (Aus der modernen Motorenfabrikation). Alexander Rothert. Discusses standards and methods for economical construction. Serial. 1st part. 3500 w. Elektrotech Zeitschr—Feb. 13, 1908. No. 95310 D.

D. C. Motors.

The Starting, Regulating and Stopping of Continuous-Current Motors. John T. Mould. The devices in use are dealt with and their advantages and disadvantages discussed. Ills. 8500 w. Public Works—July-Sept., 1908. No. 95299 B.

Direct Current Motors for Mining Service. W. B. Clark. Describes the peculiar characteristics of different types of motors and the conditions of work to which each is suited. Ills. 2500 w. Mines & Min—Sept., 1908. No. 94810 C.

D. C. Turbo-Dynamos.

The Development of the D. C. Turbo Dynamo (Zur Entwicklung der Gleichstrom-Turbodynamos). Robert Pohl. A general review of present practice. Ills. Serial. 1st part. 3200 w. Elektrotech Zeitschr—Feb. 6, 1908. No. 95308 D.

Heating.

Heating of Ventilated and Enclosed Motors. W. Hartnell. Deals with eight types of motors classified according to their system of ventilation, concluding that totally enclosed motors are at a disadvantage. Discussion. 5000 w. Electn, Lond—Aug. 21, 1908. No. 94772 A.

Induction Motors.

Influence of the Slot-Ratio Upon the Starting Torque of Induction Motors. R. E. Hellmund. A study of the variations of the torque. 1200 w. Elec Wld—Sept. 26, 1908. No. 95330.

Calculation of the Starting Torque of Single-Phase Induction Motors with Phase-Splitting Starting Devices. I. E. Hanssen. Explanatory. 300 w. Pro Am Inst of Elec Engrs—Sept., 1908. No. 94732 D.

Materials.

The Comparative Aging of Electric Sheet-Steel. T. S. Allen. Reports results of tests on core material. Also editorial. 1600 w. Elec Wld—Sept. 12, 1908. No. 95016.

See also Steel, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

Purchasing.

The Purchase of Electric Motors and Accessories. Howard S. Knowlton. Information concerning points that should be considered, etc. 3000 w. Power—Sept. 8, 1908. No. 94909.

Railway Motors.

The Alternating-Current Commutator Motor with Special Reference to Railway Motors (Ueber Wechselstrom-Kommutatormotoren mit besonderer Berücksichtigung der Bahnmotoren). M. Osnos. A mathematical discussion of the utility of this type of motor in railway work. Ills. Serial. 1st part. 2500 w. Elektrotech Zeitschr—Jan. 2, 1908. No. 95300 D.

Repulsion Motors.

The Alexanderson Series Repulsion Motor (Der Reihenschliess-Repulsionsmotor von Alexanderson). Rudolf Richter. A description and criticism of this

single-phase motor. Ills. Serial. 1st part. 2200 w. Elektrotech Zeitschr—Aug. 20, 1908. No. 95192 D.

Synchronous Motors.

Condenser Action of Synchronous Motor. Shows graphically how the rating of a synchronous motor can be calculated. 500 w. Elec Rev, Lond—Aug. 21, 1908. No. 94767 A.

Windings.

Convenient Methods for Recovering Lost Winding Data. George T. Hanchett. Describes methods for determining missing data that will save the expense of employing a dynamo designer. 1500 w. Elec Wld—Sept. 12, 1908. No. 95018.

A Winding for Polyphase Generators (Eine Wicklung für Mehrphasengeneratoren). F. Punga. Describes a new winding especially suited to three-phase dynamos. Mathematical. Ills. 5200 w. Elektrotech Zeitschr—Feb. 6, 1908. No. 95309 D.

ELECTRO-CHEMISTRY.

Cleaning Baths.

Electrochemical Cleaning Baths. Charles H. Proctor. Read before the Am. Brass Found Assn. Discusses the cleaning of metallic surfaces by the aid of the electric current. 1200 w. Ir Age—Sept. 10, 1908. No. 94906.

Corrosion.

Rusting of Iron. F. H. Mason. Considers the experimental conclusions drawn by W. A. Tilden. 1000 w. Min & Sci Pr—Sept. 5, 1908. No. 94977.

Electrolysis and Corrosion. Allerton S. Cushman. Read before the Am. Soc. for Test Mat. An examination of causes of corrosion, especially the electrolytic theory. 3500 w. Eng Rec—Sept. 26, 1908. No. 95377.

Corrosion of Iron from the Electrochemical Standpoint. C. F. Burgess. From the presidential address before the Am. Electrochemical Soc. Considers corrosion of underground structures, galvanic action, influence of strain, etc. 4500 w. Elec Rev, N Y—Sept. 12, 1908. Serial. 1st part. No. 94980.

Electro-Metallurgy.

Researches on the Electric Furnace (Untersuchungen über den elektrischen Ofen). I. On a new Laboratory Arc Furnace: Louis Clerc and Adolphe Minet. II. On Electric Arcs Burning in a Completely Closed Chamber: Adolphe Minet. Ills. 1800 w. Elektrochem Zeitschr—Aug., 1908. No. 95127 D.

Electroplating.

How to Make a Cyanide Copper Solution, and the Manner in Which It Should be Used. Explains the advantages of a cyanide-copper solution, considering the quality of the cyanide in the present number. 1200 w. Brass Wld—Sept., 1908. Serial. 1st part. No. 95268.

ELECTRO-PHYSICS.

Hysteresis.

On the Hysteresis Loss and Other Properties of Iron Alloys Under Very Small Magnetic Forces. E. Wilson, V. H. Winson, and G. F. O'Dell. Abstract of paper read before the Royal Soc. Describes experiments and gives results. 600 w. Electn, Lond—Aug. 21, 1908. No. 94771 A.

Induction Coils.

Short Spark Phenomena. W. Duddell. Describes two effects observed in connection with some measurements of the current in the secondary circuit of an induction coil. 1700 w. Electn, Lond—Sept. 4, 1908. No. 95046 A.

Ohm's Law.

The Statement of Ohm's Law. Morton G. Lloyd. A discussion, considering its application to alternating currents. 900 w. Elec Rev, N Y—Sept. 19, 1908. No. 95212.

Oscillations.

A Method for Producing Fully Damped High-Frequency Electrical Oscillations for Laboratory Measurements. L. W. Austin. Describes the arrangement found to give the best results. 700 w. Bul Bureau of Stand—Aug., 1908. No. 95386 N.

Terrestrial Magnetism.

Gilbert's Magnetic Defense of the Copernican Theory. Brother Potamian. Historical Review. 2200 w. Elec Wld—Sept. 19, 1908. No. 95214.

The Discovery of Magnetic Dip. Brother Potamian. Quotes from some early writers on magnetic philosophy, discussing the first reference in print to magnetic dip. 2800 w. Elec Wld—Sept. 12, 1908. No. 95013.

GENERATING STATIONS.

Accumulators.

Storage Batteries, Their Construction and Uses. Percival Robert Moses. Second and concluding article discussing the methods of charging and discharging types of boosters and other auxiliary apparatus, care, maintenance, cost, etc. Ills. 1500 w. Engineering Magazine—Oct., 1908. No. 95393 B.

The Influence of Temperature on the Capacity of Lead Accumulators (Einfluss der Temperatur auf die Kapazität des Bleiakkumulators). Otto Hildebrand. Gives the results of tests. 2000 w. Elektrotech u Maschinenbau—Aug. 16, 1908. No. 95174 D.

Central Stations.

Generating Station of the Borough of St. Marylebone, London. Illustrated description. 2000 w. Elec Wld—Sept. 19, 1908. No. 95215.

We supply copies of these articles. See page 326.

Recent Development of the Worcester Electric Light Company. Illustrates and describes the development. 2500 w. Elec Wld—Sept. 5, 1908. No. 94833.

The Poughkeepsie Light, Heat & Power Company. Illustrated description of a plant furnishing electrical energy for all purposes. 2500 w. Elec Wld—Sept. 5, 1908. No. 94832.

A Steam-Power Central Station of Great Economy in Operation. Illustrated detailed description of a plant at Rodondo, Cal., and the tests made. 7500 w. Eng Rec—Sept. 12, 1908. No. 94968.

Power Supply in the North of France. Abstract translation from *Le Génie Civil*, describing an undertaking for supplying the industrial district of Lille, Roubaix, Tourcoing and surrounding places. Ills. 1600 w. Elec Engng—Aug. 27, 1908. No. 94933 A.

See also Turbine Plants and Turbines, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Construction.

Some Notes on Steel Constructional Work for Central Stations. 2000 w. Elec Rev, Lond—Aug. 28, 1908. No. 94939 A.

Economics.

Industrial Power Business from a Central Station Viewpoint. W. F. Lloyd. Discusses the handling of power propositions and possible economies. 1800 w. Elec Wld—Sept. 12, 1908. No. 95020.

Germany.

Statistics of Electric Power Plants in Germany (Statistik der Elektrizitätswerke in Deutschland). Gives details of every station existing in Germany on April 1, 1907. 75000 w. Elektrotech Zeitschr—Mar. 12, 1908. No. 95316 D.

Hydro-Electric.

Seattle Power Plant and Water Supply. Jay L. Stannard. Illustrates and describes details of construction of a hydro-electric plant being greatly increased in capacity. 2500 w. Munic Jour & Engr—Sept. 9, 1908. No. 94874.

A Unique Water-Power Plant. H. Lester Hamilton. An illustrated description of a small water power utilized for Christ School, N. Carolina. 1600 w. Elec Rev, N Y—Sept. 26, 1908. No. 95372.

Hydro-Electric Station Operating Without Attendant. M. A. Hicks. Brief illustrated description of a small station at Hartland, Vt., constructed so that it carries its load at night without an attendant. 1000 w. Elec Wld—Sept. 5, 1908. No. 94840.

European Hydro-Electric Power Development. C. H. Mitchell. Read before the Can. Elec Assn. An illustrated article indicating some of the interesting features of important plants recently installed. 5800 w. Can Elec News—Sept., 1908. No. 95077.

The Urfttal Hydro-Electric Development in Germany. Frank Koester. Illustrates and describes the interesting features, the heavy masonry dam, spillway, etc. 1800 w. Eng Rec—Sept. 19, 1908. No. 95235.

The Urft Dam and the Hydro-Electric Power Transmission. Some facts concerning the disturbance of the telephone service by the high-tension currents from this plant in Rhenish Prussia. 2000 w. Engng—Aug. 21, 1908. No. 94781 A.

The Power Supply of Marseilles (L' Alimentation de Marseille en Energie Electrique). J. A. Montpellier. A description of the Brillanne-Villeneuve plant on the Durance. Ills. 2800 w. L'Elecn—Aug. 22, 1908. No. 95111 D.

The Lucerne-Engelberg Plant (Das Elektrizitätswerk "Luzern - Engelberg"). L. Pasching. Illustrated description of this Swiss plant. Serial. 1st part. 1800 w. Elektrotech Zeitschr—Aug. 6, 1908. No. 95189 D.

See also Turbine Plants, and Water Wheels, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Isolated Plants.

The Electrical Equipment of the Dan River Power & Manufacturing Company. N. H. Slaughter. Describes the interesting features of a plant near Danville, Va. 1200 w. Elec Wld—Sept. 26, 1908. No. 95329.

Rates.

Tariff Alterations. E. E. Hoadley. Considers a new system of charging made possible by the introduction of metallic filament lamps. 1500 w. Elec Rev, Lond—Sept. 4, 1908. No. 95044 A.

Switch Gear.

Switch-Gear for the Barrow Hematite Steel Works. Illustrated description of switch-gear of the flat-back type. 800 w. Engng—Aug. 21, 1908. No. 94783 A.

Voltage.

2 x 110 and 2 x 220 Volts (2 x 110 und 2 x 220 Volt). C. Heim. Discusses the influence of the metallic filament lamp on the choice of voltage for central stations. 3200 w. Elektrotech Zeitschr—Jan. 9, 1908. No. 95301 D.

2 x 110 and 2 x 220 Volts in Three-Wire Systems (Nochmals 2 x 110 und 2 x 220 Volt). C. Heim. Gives statistics of the voltage employed in German central stations, showing the predominance of 220-volt systems. Ills. 3000 w. Elektrotech Zeitschr—Aug. 6, 1908. No. 95188 D.

LIGHTING.

Arc Lamps.

The Present Status of the Flaming Arc Lamp. Alfred A. Wohlauer. Explains the principles of this lamp, describing its mechanical and illuminating features. Ills. 2000 w. Elec Wld—Sept. 5, 1908. No. 94836.

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The Flaming Arc Lamp Abroad. L. J. Auerbacher. Reports the extensive adoption of this lamp, especially in Germany. 1200 w. Elec Wld—Sept. 5, 1908. No. 94835.

Some Recent Developments in Arc Lamp Construction. Dwight D. Miller. Illustrates and describes the "Carbone" lamps, the "Polar" flaming arc lamps, and others. 2000 w. Elec Rev, N Y—Sept. 12, 1908. No. 94986.

Comparison of the Cost of Lighting by Small Arc Lamps and Osram Lamps of High Candle Power (Vergleich von Betriebskosten kleiner Bogenlampen und hochkerziger Osramlampen). Hermann Remané. Tables and curves. Ills. 3500 w. Elektrotech Zeitschr—Aug. 20, 1908. No. 95190 D.

England.

The Position of Electric Lighting in England. Albert H. Bridge. A review of progress. 2500 w. Elec Rev, N Y—Sept. 12, 1908. 94984.

Illumination.

Indoor Illuminants. James Swinburne. Discusses the leading features of the various methods of lighting. 5000 w. Public Works—July-Sept., 1908. No. 95319 B.

Incandescent Lamps.

The Tungsten Lamp. Francis W. Willcox. Considers its manufacture, life, candle-power, introduction, etc. Ills. 2000 w. Elec Wld—Sept. 5, 1908. No. 94838.

The Tungsten Lamp Situation. Various opinions from Central Station men and discussions mainly bearing on the business aspects of this lamp. Also editorial. 13000 w. Elec Wld—Sept. 5, 1908. No. 94839.

The Tungsten Lamp Situation Abroad. Dr. Louis Bell. Reports the large use of metallic filament lamps abroad. 900 w. Elec Wld—Sept. 5, 1908. No. 94834.

A Twelvemonth's Achievement of the Tungsten Lamp. S. E. Doane. Discusses the progress made in the introduction of these lamps. 1500 w. Elec Rev, N Y—Sept. 12, 1908. No. 94981.

The Effect of the Tungsten Lamp Upon Electric Lighting. L. P. Sawyer. Considers this lamp the most successful illuminant yet developed. 1000 w. Elec Wld—Sept. 12, 1908. No. 95019.

The New Westinghouse Nernst Lamp. Otto Foell. Illustrated description of new features in these lamps. 3000 w. Elec Rev, N Y—Sept. 12, 1908. No. 94983.

The Helion Lamp. H. C. Parker and W. G. Clark. Information relating to the development. 1200 w. Elec Wld—Sept. 5, 1908. No. 94837.

See also Rates, under GENERATING STATIONS; and Arc Lamps, under LIGHTING.

Inspection.

Illumination Inspection. Albert J. Marshall. Presents the advantages of such a department. 2000 w. Elec Wld—Sept. 12, 1908. No. 95021.

Mercury Vapor.

Cooper Hewitt Lamp Progress. Illustrates and describes the mechanical construction of lamps available for commercial service. 700 w. Elec Rev, N Y—Sept. 12, 1908. No. 94982.

Photometry.

A New Photometer (Ein neues Photometer). C. Paulus. Description of the new Everett Edgcumbe & Co. photometer and report of tests made with it at Munich. Ills. 2100 w. Elektrotech Zeitschr—Feb. 20, 1908. No. 95312 D.

Note on the Primary Standard of Light. C. W. Waidner and G. K. Burgess. A new suggestion for realizing a primary standard of light, and discussing the Violle standard. 3500 w. Elec Wld—Sept. 19, 1908. No. 95217.

On the Relations of the Measures of Light and Power. Carl Hering. Points out a number of weak points in the theory of photometry, discussing the subject and offering suggestions. 6000 w. Elec Wld—Sept. 19, 1908. No. 95216.

Simplifying Some of the Calculations of Light. Carl Hering. A criticism of the photometric units in use, and a discussion of the relations between illuminated and reflected surfaces. Also editorial. 4000 w. Elec Wld—Sept. 26, 1908. No. 95331.

A New Method of Determining Light-Distribution Curves and the Degree of Uniformity of Artificial Sources of Light (Ein neues Verfahren zur Aufnahme der Lichtverteilungskurve und des Gleichförmigkeitsgrades künstlicher Lichtquellen). W. Voege. Ills. 2000 w. Elektrotech Zeitschr—Jan. 16, 1908. No. 95303 D.

Vacuum Tube.

Tube Lighting. D. McFarlan Moore. Recent installations of new style tubes are illustrated and described. 1000 w. Elec Rev, N Y—Sept. 12, 1908. No. 94985.

MEASUREMENT.

Dynamo Testing.

Artificial Load for Testing Electrical Generators. Norman Young. Remarks aiming to show how much cheaper and more efficient it is to work with low conductivity water. 1400 w. Elec Rev, Lond—Sept. 4, 1908. No. 95043 A.

Inductances.

On the Measurement of Large Inductances Containing Iron. Sir Oliver Lodge and B. Davies. Describes some interesting methods and experiments. 2000 w. Elect'n, Lond—Sept. 11, 1908. No. 95286 A.

Laboratories.

The United States National Bureau of

Standards. Herbert T. Wade. An illustrated account of its equipment and its work. 6000 w. Engineering Magazine—Oct, 1908. No. 95392 B.

The Imperial Physical Laboratory in Charlottenburg (Die physikalisch-technische Reichsanstalt in Charlottenburg). Emil Warburg. A discussion of the important researches carried out and present activities. Ills. Serial. 1st part. 3000 w. Zeitschr d Oest Ing u Arch Ver—Aug. 7, 1908. No. 95162 D.

Meters.

Care and Adjustment of General Electric Recording Watt-hour Meters. O. F. Dubruiel. Directions. 1500 w. Power—Sept. 22, 1908. No. 95254.

A New Direct Current Ampere-hour Meter A. Königswerther. Abstract trans. from *Elek. Zeit.* Describes an instrument claimed by the author to give readings correct at all loads. 1000 w. Electn, Lond—Aug. 28, 1908. No. 94940 A.

Metering and Its Attendant Losses. Deals with the losses that are inseparable from any system of measurement of electricity by meter. 700 w. Elec Rev, Lond—Sept. 11, 1908. No. 95282 A.

Notes on the Measurement of Power in Alternating Current Circuits. J. W. Rogers. Describes the construction of a water meter, and considers the measurement of power in a polyphase circuit. 1600 w. Prac Engr—Aug. 28, 1908. Serial. 1st part. No. 94926 A.

Permeability.

Notes on the Plug Permeameter. C. V. Drysdale. Abstract of a paper before the Physical Soc. Describes tests which the author claims show that the plug permeameter gives as good results as other methods of iron testing. 1000 w. Electn, Lond—Aug. 28, 1908. No. 94942 A.

Power Factor.

Two Wattmeter Method of Measuring Power Factor Considered Graphically. Indicates a method of representing and measuring the power factor of three-phase circuits graphically. 1200 w. Elec Engr, Lond—Aug. 28, 1908. No. 94936 A.

Phase and Power-Factor Meters (Phasemètres et Indicateurs du Facteur de Puissance). A. R. Garnier. Brief descriptions and mathematical discussions of various types. Ills. 3000 w. L'Elecn—Aug. 15, 1908. No. 95110 D.

Standards.

Report of the British Association Committee on Practical Standards for Electrical Measurements. Slightly abbreviated. 4000 w. Electn, Lond—Sept. 11, 1908. Serial. 1st part. No. 95287 A.

TRANSMISSION.

The Theory of Cables (Zur Theorie der Kabel). Leon Lichtenstein. A theoretical and mathematical discussion. Ills. Serial. 1st part. 4500 w. Elek Kraft u Bahnen—Aug. 4, 1908. No. 95168 D.

High-Tension Underground Cable Operation. Henry Floy. On the reliability and present status of underground high-tension distribution. 2000 w. Elec Wld—Sept. 26, 1908. No. 95333.

High-Tension Cables and Transmission (Hochspannungskabel und Hochspannungs-Kraftübertragungen). Richard Apt. Discusses the requirements of a cable for high-tension transmission, etc. Ills. Serial. 1st part. 2200 w. Elektrotech Zeitschr—Feb. 20, 1908. No. 95311 D.

Current Rectifiers.

Some Contact Rectifiers of Electric Currents. L. W. Austin. Gives results of experimental investigations of silicon tellurium, etc., with conclusions. 3000 w. Bul Bureau of Stand—Aug., 1908. No. 95385 N.

Earthing.

Earthing. Discusses the connections to earth advisable to prevent accidents. 1000 w. Elec Engr, Lond—Aug. 28, 1908. No. 94937 A.

Inductance.

Formulae and Tables for the Calculation of Mutual and Self-Inductance. Edward B. Rosa and Louis Cohen. A collection of formulae of value, with examples to illustrate and test them, and useful tables. 30000 w. Bul Bureau of Stand—Aug., 1908. No. 95384 N.

Insulation.

The Potential of Partially Insulated Systems in Relation to the Potential of Earth. M. B. Field. A discussion of points having a bearing on efficient insulation. 7000 w. Elec Engr, Lond—Aug. 28, 1908. No. 94935 A.

Insulators.

Porcelain Insulators for High Voltage Lines. J. A. Sandford, Jr. Considers the Requirements of good insulators, how they are made, tested, etc. 3500 w. Cent Sta—Sept., 1908. No. 94964.

The Effect of Temperature on the Breakdown Voltage of Insulators. Abstract translation from *Elektrotechnik und Maschinenbau.* Discusses the experimental investigations of Prof. A. Grau at the Vienna Tech. Inst. 900 w. Elec Engr, Lond—Sept. 11, 1908. No. 95279 A.

Line Design.

The Design of Underground Mains and Networks. J. R. Dick. Considers the general design of low-tension network, giving useful methods. Graphical methods are discussed, and a law for determining the best feeder areas. 3500 w. Elect'n, Lond—Sept. 11, 1908. Serial. 1st part. No: 95285 A.

Lines.

Steel Tower Transmission. Line of the Milwaukee Electric Railway & Light

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Company. Illustrated description. 1000 w. Elec Ry Jour—Sept. 26, 1908. No. 95346.

Protective Devices.

The "Merz-Price" System of Automatic Protection for High-Tension Circuits. Reviews the underlying principles and the applications made. Ills. 3000 w. Elec Rev, Lond—Aug. 28, 1908. No. 94938 A.

Rotary Converters.

Parallel Operation of Rotary Converters. H. R. Mason. Explains different methods of cutting in or out. Ills. 1800 w Power—Sept. 15, 1908. No. 95060.

The Cascade Converter. August Bloch. Abstract translation from *Elektrotechnik und Maschinenbau.* Description and explanation of its working. 3500 w. Elect'n, Lond—Sept. 4, 1908. No. 95045 A.

Three-Phase.

A Method of Balancing the Load on and Improving the Power Factor of Three-Phase Systems. A. A. Radtke. Explains difficulties in methods used, and describes a new method. 1600 w. Elec Wld —Sept. 12, 1908. No. 95015.

Three-Wire System.

The Three-Wire System with Two Dynamos. Cecil P. Poole. Explanation of the principles governing the operation. Ills. 1200 w. Power—Sept. 22, 1908. No. 95249.

Transformers.

Transformer Design (Ueber die Berechnung von Transformatoren). Emil Alm. Works out the dimensions of a transformer for a special case. Mathematical. Ills. 3000 w. Elektrotech Zeitschr—March 5, 1908. No. 95314 D.

Voltage Drop and Leakage in Transformers (Spannungsabfall und Streuung der Transformatoren). Gustav Benischke. A mathematical discussion. Ills. 4000 w. Elektrotech Zeitschr—Jan. 23, 1908. No. 95305 D.

See also Insulating Oils, under MISCELLANY.

Voltage Regulation.

Regulators for Alternating-Current Work. A. A. Tirrill. Illustrated description of two types and the method of operation. 1000 w. Elec Jour—Sept., 1908. No. 95066.

The Theory of the Tirrill Regulator (Zur Theorie des Tirrill-Regulators). M. Seidner. Ills. 2000 w. Elektrotech u Maschinenbau—Aug. 9, 1908. No. 95171 D.

Wire Joints.

Wire Joining in Transmission Lines (Ueber Drahtbundverfahren für Freileitungen). Robert Nowotny. Illustrates and discusses various methods. 2500 w. Elektrotech u Maschinenbau—Aug. 23, 1908. No. 95175 D.

MISCELLANY.

Accidents.

Report of the Electrical Inspector of Factories for the Year 1907. G. Scott Ram. On electrical accidents, dangerous conditions needing correction, etc. 2500 w. Mech Engr—Aug. 21, 1908. No. 94766 A.

Insulating Oils.

Switch and Transformer Oil. A study of the insulating oil question. 3000 w. Elec Rev, Lond—Sept. 11, 1908. Serial. 1st part. No. 95281 A.

INDUSTRIAL ECONOMY

Accounting.

Modern Office Practice. Ridgley Newcomb. A synopsis of the development of modern methods and machinery for office use. 4000 w. Ir Trd Rev—Sept. 17, 1908. Serial. 1st part. No. 95200.

Latest Developments in the Burroughs' System of Book-Keeping and Accounting. I. Development of the Accounting Machine. R. L. Burd. II. Mechanical Accounting. Thomas M. Jones. 3800 w. Jour Fr Inst—Sept., 1908. No. 94728 D.

Apprenticeship.

The Future of the Apprentice. R. I. Graves. A paper by one of the apprentices of the C. & N.-W. R. R. 1500 w. Am Engr & R R Jour—Sept., 1908. No. 94828 C.

Cost Systems.

Obtaining Actual Knowledge of the Cost of Production. F. E. Webner. This sixth article of the series deals with cost records as a part of the general accounting plan. 1800 w. Engineering Magazine—Oct., 1908. No. 95398 B.

Systematic Foundry Operation and Foundry Costing. C. E. Knoeppel. This first article of a series outlines the elements of the problem. 3500 w. Engineering Magazine—Oct., 1908. No. 95400 B.

Drafting Room Costs (Die Kosten des Zeichensaales.) F. Kerner. Outlines a system for the determination and distribution of drafting costs. Ills. 2500 w. Technik u Wirtschaft—Aug., 1908. No. 95126 D.

Education.

Technical Education in Spain (La Instrucción Técnico-Industrial en España). José G. Benítez. A general discussion of conditions. Ills. 2000 w. Energia Elec—Aug. 10, 1908. No. 95125 D.

The Partiality to Theory in Mechanical Engineering Education in the Technical High Schools of Germany (Inwiefern ist die Ausbildung der Maschineningenieure an unseren deutschen technischen Hoch-

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schulen eine einseitige). Theodor Löhe. Serial. 1st part. 2000 w. Die Turbine—Aug. 5, 1908. No. 95149 D.

Fire Loss.

The Discouragement of Preventable Fires. James C. Bayles. The importance of investigating all cases of fire, with remarks on the annual loss, and on methods in Berlin. 1500 w. Cassier's Mag—Sept., 1908. No. 94739 B.

Management.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. This fourth article of the series considers standards; their relation to organization and to results. 4500 w. Engineering Magazine—Oct., 1908. No. 95394 B.

Apportioning Overhead Charges to Flat Cost. Oscar E. Perrigo. Twelfth of a series of articles on shop management and cost keeping. 4000 w. Ir Trd Rev—Sept. 3, 1908. No. 94844.

Stores Keeping.

System in Handling Material. N. M. Rice. Outlines a standard system, considering details. Ills. 2500 w. R R Age Gaz—Sept. 18, 1908. No. 95264.

Foundry Warehouse Methods. F. C. Everitt. Read before the Am. Found. Assn. Outlines two methods for stock accounting to be used in conjunction or separately. 1600 w. Ir Age—Sept. 3, 1908. No. 94812.

Tariffs.

The Collection of Data for Tariff Revision. Concerning efforts being made to collect reliable data of foreign cost of production, and other related matters. 1800 w. Ir Age—Sept. 10, 1908. No. 94904.

The Recently Proposed French Tariff. Translation of the suggestions reported by the Commission of French Manufacturers of machine and small tools asking for higher duties. 6000 w. Am Mach—Vol. 31. No. 37. No. 94920.

Trusts.

Combinations in the German Machinery Trade. Outlines the arrangements made in the direction of obviating competition. 1200 w. Engr, Lond—Sept. 11, 1908. No. 95293 A.

Waste.

National Waste. Oskar Nagel. Brief consideration of needed economy in the United States in connection with industries, the fuels, refuse, etc. 1500 w. Elec-Chem & Met Ind—Sept., 1908. No. 94725 C.

MARINE AND NAVAL ENGINEERING

Battleships.

The Brazilian Battleship "Minas Geraes." Illustration, description, and armament. 1000 w. Engng—Sept. 11, 1908. No. 95091 A.

H. M. Battleships "Agamemnon" and "Lord Nelson." Illustrated description of the two latest ships added to the British fleet. Plate. 1000 w. Engng—Sept. 4, 1908. No. 95050 A.

Compasses.

The Modern Developments of the Mariner's Compass. J. C. Dobbie. Information concerning the invention and adjustment of the compass, and the different types used. Ills. 2500 w. Marine Rev—Aug. 27, 1908. Serial. 1st part. No. 94700.

Cruisers.

The Trials of the Russian Armored Cruiser "Rurik." Editorial on the exhaustive trials and their success. 3300 w. Engng—Sept. 11, 1908. No. 95089 A.

Destroyers.

The British 38-Knot Destroyer "Swift." Illustration and brief description of a vessel said to be the fastest afloat. 600 w. Sci Am—Sept. 5, 1908. No. 94899.

Recent French Torpedo Boat Destroyers. Illustrations and information relating to these vessels. 1500 w. Engr, Lond—Aug. 21, 1908. No. 94788 A.

Dredges.

A Powerful Russian Hydraulic Dredge. H. Prime Kieffer. Illustrated description of the most powerful dredge ever constructed, built in Belgium; also report of trials. 2000 w. Ir Age—Sept. 24, 1908. No. 95324.

Electric Power.

See Steering Gear, under MARINE AND NAVAL ENGINEERING.

Ferry Boats.

The New Ferry Boat in Kiel Harbor (Die neuen Fahrdampfer des Kieler Hafens). Fr. Bertram. Illustrated description. Plates. 3300 w. Schiffbau—Aug. 26, 1908. No. 95160 D.

Internal-Combustion Engines.

The Field for the Combustion Motor in Marine Work (Anwendungsgebiete des Motors in der Schiffahrt). F. W. von Viebahn. Discusses the application of the combustion motor to various classes of vessels; compares it with steam engines and turbines, etc. Serial. 1st part. 2500 w. Schiffbau—July 25, 1908. No. 95158 D.

Japan.

Naval and Merchant Shipbuilding in Japan. A review of progress in this field. 4000 w. Engng—Aug. 21, 1908. No. 94782 A.

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Lusitania.

The Performance of the New Steamers "Mauretania" and "Lusitania." Extract from an article by Sir William H. White, in the *London Times*, with comments. 1500 w. Eng News—Sept. 10, 1908. No. 95006.

Marine Transport.

The Earning Power of Ships (Beitrag zu einer Kritik der Rentabilität von Schiffen). Otto Alt. The first part discusses mathematically the general theory of profits. Serial. 1st part. 2500 w. Schiffbau—Aug. 12, 1908. No. 95156 D.

Model Basins.

German Experimental Tanks. General remarks, and illustrated detailed description of the three most recent tanks in Germany. 4000 w. Engr, Lond—Aug. 21, 1908. Serial. 1st part. No. 94785 A.

Motor Boats.

A Motor Launch for the River Tyne. Illustrated description of the oil-engine and reversing gear for the launch "Comet." 1200 w. Engr, Lond—Sept. 11, 1908. No. 95294 A.

Navigation.

New Aids for Navigation. Henry Emerson Wetherill. Brief illustrated descriptions of new instruments for special uses. 2000 w. Jour Fr Inst—Sept., 1908. No. 94730 D.

Resistance.

The Determination of Ships' Resistance (Iets over de Bepaling van den Weerstand van Schepen). J. K. E. Triebart. A mathematical discussion based on tests on models. Ills. 11500 w. De Ingenieur—Aug. 1, 1908. No. 95194 D.

Shipbuilding.

Reinforced Concrete as a Building Material for Boats. Illustrates and describes the system evolved by Carlo Nabellini, of Rome, Italy. 2000 w. Sci Am—Sept. 5, 1908. No. 94898.

New Repair Works of the Clyde Trust. Illustrates and describes the new works at Renfrew, for the repair and up-keep of the floating plant and shore appliances of the Clyde Trustees. 3500 w. Engr, Lond—Sept. 11, 1908. No. 95291 A.

Angle Iron in the Construction of Trading Vessels (Die Winkelprofile im Handelsschiffbau). Carl Kielhorn. Describes the historical development of the angle profile and the sections now available. 3100 w. Stahl u Eisen—Aug. 26, 1908. No. 95133 D.

Ship Design.

A Note on the Dimensioning of Ships (Beitrag zur Dimensionierung von Schiffen). Alfred Schmidt. Develops new and reliable formulae. Ills. 3600 w. Schiffbau—Aug. 26, 1908. No. 95159 D.

Steam Boilers.

Some Remarks on the Design, Construction and Working of the Marine Boiler. Richard Hirst. Opinions on the practice of boiler construction and working. 4000 w. Mech Wld—Sept. 1, 1908. No. 95273 A.

Steam Turbines.

Turbines at the German Shipbuilding Exhibition, 1908 (Die Turbomaschinen der Deutschen Schiffbau-Ausstellung, 1908). Illustrated description of the exhibits for marine work. Serial. 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Aug. 20, 1908. No. 95147 D.

See also Condensers, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Steering Gear.

Electrical Operation of Steering Gear (Ueber den elektrischen Antrieb des Schiffssteuers). A Stauch. A comprehensive discussion of this application of electric power, the motors best adapted, etc. Ills. Serial. 1st part. 6000 w. Schiffbau—Aug. 12, 1908. No. 95157 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Adler.

The Adler Petrol Cars. Illustrated detailed description of a car built in Germany. 1500 w. Auto Jour—Aug. 22, 1908. Serial. 1st part. No. 94756 A.

Alldays.

The Alldays Petrol Cars. Illustrated detailed description. 800 w. Auto Jour—Sept. 5, 1908. Serial. 1st part. No. 95030 A.

American.

Concerning the Seven 1909 Americans. Illustrations and information relating to the seven models of the American Motor Car Co. 2000 w. Automobile—Sept. 3, 1908. No. 94849.

Cabs.

The Work and Design of Motor Cabs. Discusses details, giving diagrams of tests carried out. 1800 w. Engng—Aug. 28, 1908. No. 94948 A.

Carbureters.

Getting Acquainted With a Carbureter. Herbert L. Towle. Suggestions for amateurs. Ills. 2500 w. Automobile—Sept. 24, 1908. No. 95344.

Clutches.

The Crossley Car and Its Expanding Clutch. Illustrates and describes this

clutch. 1200 w. Auto Jour—Aug. 22, 1908. No. 94758 A.

Commercial Vehicles.

Motor Apparatus for Fire Departments. George W. Kerr. Considers the advantages of motor-driven vehicles over horse-drawn. 2500 w. Com Vehicle—Sept., 1908. No. 94815 C.

See also Springs, under AUTOMOBILES.

Ford.

Ford Light Touring Car for 1909. Illustrated description of a low-priced car. 2000 w. Automobile—Sept. 24, 1908. No. 95345.

Ignition.

A Chapter on Magnet Construction. Illustrated description of the new Bosch coil. 700 w. Automobile—Sept. 10, 1908. No. 94972.

High-Tension Magneto-Ignition Systems. Illustrates and describes the Gibaud Magneto, a machine of French origin. 1000 w. Auto Jour—Aug. 22, 1908. Serial. 1st part. No. 94757 A.

Lamps.

The Troubetzkoy Acetylene Lamps. A lamp manufactured in Milan, is illustrated and described. 1000 w. Auto Jour—Aug. 22, 1908. No. 94759 A.

Motor Cooling.

Radiator Efficiency Investigations. Dr. W. R. Ormandy and J. H. Lester. An account of investigations of several systems of cooling. 3000 w. Autocar—Aug. 22, 1908. No. 94753 A.

Motor Rating.

Rating an Automobile Engine. Thomas L. White. Explains method of determining horse power from the cylinder dimensions. 3000 w. Sci Am Sup—Sept. 12, 1908. No. 94996.

Horse Power Ratings of Automobile Motors. Thomas J. Fay. Discusses the importance of the stroke, its effect on compression, conditions affecting the torque, etc. 2500 w. Automobile—Sept. 24, 1908. Serial. 1st part. No. 95343.

Motors.

The Direct Injection of Motor Fuel. Thomas J. Fay. Discusses the essential elements of direct injection and related subjects. 3500 w. Automobile—Sept. 3, 1908. No. 94848.

Why the Long Stroke for Motors? S. F. Edge. Discusses why the long-stroke engine is being developed for racing cars, considering the objections to excessively long strokes. 2000 w. Automobile—Sept. 17, 1908. No. 95098.

Rover.

The 20 H. P. T. T. Rover Car. Illustrated description of a car that took part in the Tourist Trophy race. 2000 w. Autocar—Aug. 22, 1908. No. 94754 A.

Siddeley.

The Siddeley Motor Cab. Drawings and detailed description. 1000 w. Engng—Aug. 28, 1908. No. 94950 A.

Springs.

A Discussion of Commercial Vehicle Springs. Morris A. Hall. Discusses types usually employed, methods of suspension, etc. 2500 w. Com Vehicle—Sept., 1908. No. 94814 C.

Steering Gear.

The Steering Gear. An illustrated discussion of its defects and how they may be remedied. 3500 w. Autocar—Sept. 5, 1908. No. 95029 A.

A Study of Steering Connections. William Wreford. Illustrates faults shown in the ball and cup joints. 1500 w. Autocar—Aug. 22, 1908. No. 94755 A.

Stoddard-Dayton.

Stoddard-Dayton, 1909. Illustrated description. 2000 w. Automobile—Sept. 10, 1908. No. 94973.

Tires.

Motor Cycle Tires and Accessories. H. Gillard Cove. Abstract of paper read before the Auto Cycle Union. Gives the writer's experience and much general information. 3500 w. Auto Jour—Aug. 29, 1908. No. 94922 A.

Tractors.

The "Walking Engine." An illustrated account of the latest developments, and future prospects of the "Diplock" pedrail. 2800 w. Auto Jour—Sept. 5, 1908. No. 95031 A.

Trenching Machine.

An Automobile Trenching Machine (Charrue Automobile Militaire). G. Espitallier. Illustrated description. 3200 w. Génie Civil—Aug. 8, 1908. No. 95113 D.

Troubles.

Suggestions for the Man Who Drives His Car. Thomas J. Fay. Cases of trouble and the remedies are given. 1200 w. Automobile—Sept. 10, 1908. Serial. 1st part. No. 94971.

Vinot.

The 12 x 16 H. P. Vinot Car. Illustrated detailed description. 1200 w. Autocar—Aug. 29, 1908. No. 94923 A.

Wear.

Cause and Prevention of Wear in Motor-Driven Vehicles. F. H. Royce. Considers the causes of, and remedies for, wear in private cars. Ills. 2000 w. Auto Jour—Sept. 12, 1908. No. 95271 A.

Zedel.

The 15 H. P. Four-Cylinder Zedel. Illustrated detailed description of the chassis. 1400 w. Autocar—Sept. 12, 1908. Serial. 1st part. No. 95272 A.

COMBUSTION MOTORS.

Fuels.

Internal Combustion for Rotary Prime Motors. Edward C. Warren. Proposals for fuel and oxygen supply, indicating the

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lines the writer believes would prove successful. 3000 w. Engineering Magazine —Oct, 1908. No. 95395 B.

Gas Engine Failures.

Gas and Oil Engine Breakdowns and Their Lessons. Michael Longridge. From the annual report of the Chief Engineer of the British Engine, Boiler & Elec. Ins. Co., Ltd., giving causes of failures. 4500 w. Mech Engr—Sept. 4, 1908. No. 95034 A.

Gas Engines.

The Du Bois Tandem Gas Engine. George W. Malcolm. Illustrates and describes a new angle acting type. 1200 w. Power—Sept. 8, 1908. No. 94907.

Gaseous Explosions. First report of the committee appointed by the British Association for the investigation of gaseous explosions, with special reference to temperature. 13000 w. Engng—Sept. 11, 1908. Serial. 1st part. No. 95094 A.

The Influence of Mixture Ratio on the Thermal Efficiency of Internal Combustion Motors (Influence de la Proportion du Mélange sur l'Utilisation thermique du Fluide Moteur dans les Moteurs à Explosions). K. Kutzbach. Translated from *Zeitschr. d. Ver. Deutscher Ing.* Ills. Serial. 1st part. 2500 w. All Indus —Aug., 1908. No. 95108 D.

Gasoline Engines.

A Gasoline Motor With Rotating Cylinders. Illustrated description of Farwell motors and their control. 2000 w. Eng News—Sept. 10, 1908. No. 95008.

Economy in Gasoline Engine Operation. P. F. Walker. Considers conditions which tend to give economical results. 2000 w. Power—Sept. 1, 1908. No. 94750.

Horse Power Formulae for Petrol Engines. Gives some features of the report of the sub-committee of the Society of Motor Manufacturers and Traders. 4500 w. Autocar—Aug. 29, 1908. No. 94924 A.

Gas Power Plants.

The Gas Engine as Applied to the Operation of Textile Mills. A. Vennell Coster. Illustrates and describes successful applications of gas power in Lancashire manufactories. 4000 w. Cassier's Mag—Sept. 1908. No. 94734 B.

The Producer Gas Power Plant of the Minneapolis & St. Louis. Illustrated description of the first power plant of this character to be used for an American railroad shop. 1500 w. R R Age Gaz—Sept. 18, 1908. No. 95260.

Gas Power Standards.

Gas Power Section—Progress Report of the Committee on Standardization. Gives communications on various subjects received by the committee. 8000 w. Jour Am Soc of Mech Engrs—Sept., 1908. No. 95069 F.

Gas Producers.

The Suction Gas Producer Plant at the Shops of Fairbanks, Morse & Co. Illustrated description. 1200 w. Eng Rec—Sept. 5, 1908. No. 94872.

The Production of Cheap Power by Suction Gas Plants. Philip W. Robson. Read before the British Assn. at Dublin. Remarks on the development of these producers, explaining the principle of working, the advantages, etc., and giving much information. 5000 w. Engng—Sept. 11, 1908. No. 95087 A.

Oil Engines.

See Gas Engine Failures, under COMBUSTION MOTORS; and Motor Boats, under MARINE AND NAVAL ENGINEERING.

Producer Gas.

Producer Gas. J. Emerson Dowson. Read before the British Assn. at Dublin. Reviews the progress of recent years, results of practical experience and future possibilities. 3500 w. Engng—Sept. 11, 1908. No. 95092 A.

Water Gas.

Water Gas (Wassergas). Ottoman Kayser. Discusses the apparatus, methods and costs of its production. Ills. 5500 w. Oest Zeitschr f d Oeffent Baudienst—Aug. 15, 1908. No. 95164 D.

HEATING AND COOLING.

Air Cooling.

Air Cooling. Theodore Weinshank. Read before the Am. Soc. of Heat. & Vent. Engrs. Discusses problems in connection with air-washing. 1800 w. Heat & Vent Mag—Aug., 1908. No. 94744.

Engineering.

Reasons Why the Science of Heating and Ventilating Engineering Should be Observed. J. D. Hoffman. Read before tracts, etc. 3000 w. Heat & Vent Mag—Discusses the general requirements, contracts, etc. 3000 w. Heat & Vent Mag—Aug., 1908. No. 94742.

Heat Regulators.

An Automatic Heat-Regulator. Illustrated description of a device depending for its operation upon the law of the variation of vapor tension with differences in temperature. 1200 w. Sci Am Sup—Sept. 12, 1908. No. 94997.

Hot-Air Heating.

A Hot-Air Furnace in a House Without a Cellar. R. S. Thompson. Read before the Am. Soc. of Heat. & Vent. Engrs. Sketches and description of method used. 1500 w. Heat & Vent Mag—Aug., 1908. No. 94743.

Heat Transmission over Long Distances (Ueber Fernleitung von Wärme). O. Krell. A mathematical discussion, particularly of the use of hot air. Ills. 3800 w. Gesundheits-Ing—Aug. 29, 1908. No. 95153 D.

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Hot-Water Heating.

The Schott Systems of Central Station Heating. J. C. Hornung. Gives briefly the history of steam and hot water systems, and describes Schott's balanced column hot water system, and the regulated steam system. 2800 w. Jour Assn of Engng Socs—Aug., 1908. No. 95401 C.

See also Shop Heating, under MACHINE WORKS AND FOUNDRIES.

Liquid Helium.

The Latest Advance Towards the Absolute Zero. Francis Hyndman. Information concerning the work of Prof. H. Kamerlingh Onnes, and his apparatus for the liquefaction of helium. Ills. 2000 w. Engng—Aug. 28, 1908. No. 94947 A.

Radiation.

Coefficient of Transmission in Cast Iron Radiation. John R. Allen. Read before the Am. Soc. of Heat. & Vent. Engrs. Gives results of tests made to determine the variation of the coefficient of conditions with different temperatures of steam and air on the two sides of a cast-iron radiator. 1200 w. Heat & Vent Mag—Aug., 1908. No. 94745.

Radiators.

The Relative Efficiency and Durability of Cast Iron and Pressed Steel Radiators. Ray D. Lillibridge. Short discussion. Ills. 1000 w. Heat & Vent Mag—Sept., 1908. No. 95404.

Refrigeration.

Manhattan Refrigerating Plant. Illustrates and describes the construction of the buildings, and the safeguards against loss by fire. 3000 w. Ins Engng—Sept., 1908. No. 95406 C.

The Absorption Refrigeration Machine. Gardner T. Voorhees. Describes the volatile liquid refrigerating machine, the compression machine, and the absorption machine. 4500 w. Ice & Refrig—Sept., 1908. Serial. 1st part. No. 94873 C.

Experiments with Binary Refrigeration. Edgar Penney. Read at meeting of Am. Soc. of Refrig. Engrs. Reviews the use of binary gases in refrigeration, experiments and conclusions, tests, etc., giving criticisms of the plant and explaining the theory on which it is based. Ills. 1500 w. Cold Storage & Ice—Sept., 1908. No. 95076 C.

Vapor Pressure of Dilute Ammonia Solutions (Dampfdruck von wässrigen Ammoniaklösungen). Hilde Mollier. Reports extensive investigations of the relation between condensation, pressure and temperature of dilute ammonia solutions, with reference to the absorption system of refrigeration. Ills. 3500 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 1908. No. 95182 D.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Steam Heating.

An Exhaust Central Station Steam Heating Plant. James A. White. Describes a plant at West Chester, Penn., which supplies heat to over 200 customers in business blocks, residences, etc. 3000 w. Dom Engng—Aug. 29, 1908. No. 94708.

See also Hot-Water Heating, under HEATING AND COOLING.

Ventilation.

The Requirements of Good Ventilation. Walter B. Snow. A statement of the principal facts and laws governing ventilation giving practical applications, particularly with reference to the combined system of forced circulation and indirect steam heating. 3000 w. Dom Engng—Sept. 19, 1908. No. 95079.

Ventilation of the First Church of Christ, Scientist, Boston. Charles L. Hubbard. Detailed description of method, explaining conditions. 2000 w. Eng Rec—Sept. 19, 1908. No. 95232.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Diversified Uses of the Centrifugal Pump. E. F. Doty. Their adaptation in boiler feeding, dry dock and sewage pumping and general industrial purposes. 2500 w. Power—Sept. 1, 1908. No. 94752.

Hydrostatics.

Pressure of the Atmosphere on Liquids. Franklin van Winkle. Considers conditions of equilibrium in liquid columns, siphonage, etc. Ills. 3500 w. Power—Sept. 8, 1908. No. 94915.

Piping.

See Steam Pipes, under STEAM ENGINEERING.

Pumping Plants.

The Pumping Stations of the Intercepting Sewer System of Chicago. Plans, illustrations, with descriptions and general information. 4500 w. Eng News—Sept. 10, 1908. No. 95007.

The Pumping Plant of the Huntley Irrigation Project. F. W. Hanna. Illustrated description of a pumping system on the Yellowstone River, Montana. 1200 w. Eng News—Sept. 3, 1908. No. 94866.

See also Purification, under CIVIL ENGINEERING, WATER SUPPLY.

Pump Valves.

The Design of Pump Valves (Berechnung der Pumpenventile). Georg Lindner. An exhaustive mathematical discussion. Ills. 4500 w. Zeitsch d Ver Deutscher Ing—Aug. 29, 1908. No. 95186 D.

Turbine Plants.

The Cost of Water Power Plants (Baukosten von Wasserkraftanlagen). K. Thielsch. Enumerates the items in the cost of turbine and hydro-electric plants, giving costs of a large number of plants.

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Tables and curves. 3200 w. Zeitschr f d Gesamte Turbinenwesen—Aug. 20, 1908. No. 95146 D.

Water-Wheel Governors.

A Water Wheel Governor and Its Operation. D. Ben Replogle. Gives diagrams showing the movements of the governor described. 1200 w. Min & Sci Pr—Sept. 5, 1908. No. 94978.

A New Type of Water Wheel Governor. Simpson Rice. Illustrates and describes an oil-pressure governor recently brought out, and its operation. 2500 w. Power—Sept. 15, 1908. No. 95062.

Water Wheels.

The Pelton Wheel Installation at the Nordhausen Municipal Electric Station (Die Peltonradanlage des Elektrizitätswerkes der Stadt Nordhausen). A. Pfarr. Illustrated description of a large installation. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 1, 1908. No. 95176 D.

MACHINE ELEMENTS AND DESIGN.

Clutches.

A Spring-Cushioned Clutch. Albert Walton. Describes its construction and operation. Ills. 1000 w. Am Mach—Vol. 31, No. 37. No. 94917.

Drafting Offices.

A Simple Drawing Office System. Ernest A. Vessey. Describes a simple, cheap and satisfactory system. 2000 w. Engr, Lond—Aug. 21, 1908. No. 94790 A.

Gears.

Laying Out Spur Gears (Die Bearbeitung der Zähne von Stirnrädern). P. Gerlach. A theoretical discussion of the method of designing the teeth. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 8, 1908. No. 95179 D.

Graphical Charts.

The Construction of Graphical Charts. John B. Peddie. Considers alinement charts with double scales and two pairs of axes, the hexagonal index chart, and a modification. 6000 w. Am Mach—Vol. 31, No. 36. No. 94831.

Riveted Joints.

The Distribution of Stresses in Riveted Joints (Zur Kraftverteilung in genieteten Stäben). Ivan Arnovlevic. Mathematical. Ills. 8000 w. Oest Zeitschr f d Oeffent Baudienst—Aug. 22, 1908. No. 95166 D.

Stuffing Boxes.

Designing Labyrinth Stuffing Boxes for Steam Turbines. P. Faber. Gives a method of calculating packings of labyrinth stuffing boxes, giving graphical solution. 1200 w. Power—Sept. 8, 1908. No. 94914.

MACHINE WORKS AND FOUNDRIES.

Automatic Machines.

See Chain Driving, under POWER AND TRANSMISSION.

Blacksmith Shops.

Tools for the Blacksmith Shop. James Cran. Suggestions for serviceable and satisfactory tools. Ills. 2000 w. Mach, N Y—Sept., 1908. No. 94803 C.

Boring.

Locating and Boring Oblique Holes in Jigs. C. L. Goodrich. Directions and methods. Ills. 1200 w. Am Mach—Vol. 31, No. 37. No. 94916.

Brass Founding.

Quartz Crucibles. Explains what they will and will not do. 600 w. Brass Wld—Sept., 1908. No. 95267.

Making Art Metal Work in Gutta-Percha Molds. The advantage of these molds, their manufacture and use. Ills. 1500 w. Brass Wld—Sept., 1908. No. 95266.

The Color of Brass Foundry Alloys. J. F. Buchanan. An exhaustive discussion of the color problem in so far as it effects alloys for castings. Ills. 3000 w. Foundry—Sept., 1908. No. 94716.

Care and Personal Attention Necessary to Produce Brass Goods of a Strictly High Grade Nature. Joseph H. Glauber. Read before the Metal Work. Club. Explains the methods and the great care needed. 2500 w. Dom Engng—Sept. 5, 1908. No. 94850.

Quality vs. Quantity in the Brass Foundry. J. N. Gamble. Read before the Am. Brass Found. Assn. Shows that quality and quantity must go together, and gives suggestions. 1800 w. Foundry—Sept., 1908. No. 94718.

A Résumé of the Effect of Impurities on Brass Intended for Rolling. Erwin S. Sperry. An illustrated article indicating the effect of the various metallic and non-metallic elements. 3500 w. Brass Wld—Sept., 1908. No. 95265.

See also Cleaning Baths, under ELECTRICAL ENGINEERING, ELECTRO-CHEMISTRY.

Castings.

Small Piston-Ring Castings. Walter J. May. Suggestions for their economical production. 500 w. Prac Engr—Aug. 28, 1908. No. 94925 A.

Cupolas.

Foundry Cupola Construction. Thomas D. West. Read before the N. Eng. Found. Assn. Discusses the features required to meet special conditions. 2500 w. Ir Age—Sept. 24, 1908. No. 95325.

Oil-Fired Cupolas (Ueber Kupolöfen für Oelfeuerung). Illustrated description of various firing devices, their efficiency, etc. 2500 w. Stahl u Eisen—Aug. 19, 1908. No. 95132 D.

Dies.

Threading Dies. Erik Oberg. Illustrated descriptions of their design, manufacture, and uses. 2500 w. Mach, N Y—Sept., 1908. No. 94804 C.

Enameling.

See Furnaces, under MACHINE WORKS AND FOUNDRIES.

Force Making.

Making Forces for Embossed Work. Chester L. Lucas. Describes methods of making forces. Ills. 1500 w. Am Mach—Vol. 31. No. 37. No. 94918.

Forging.

Drop Forge Work in an Automobile Shop. Ethan Viall. Illustrates and describes methods used in a factory at Kenosha, Wis. 2000 w. Mach, N Y—Sept., 1908. No. 94802 C.

Foundry Management.

See Cost Systems, and Stores Keeping, under INDUSTRIAL ECONOMY.

Foundry Materials.

The Testing of Foundry Irons. F. J. Cook. From the presidential address before the British Found. Assn. at Newcastle-on-Tyne. Discusses important tests. Ills. 2500 w. Ir & Coal Trds Rev—Sept. 11, 1908. No. 95296 A.

The Properties of Ferro-Silicon. From a report of D. R. Wilson it is said that it possesses explosive and poisonous characteristics which should be considered in its transportation. 1000 w. Ir & Coal Trds Rev—Sept. 11, 1908. No. 95297 A.

The Utilization of High Percentage Ferro-Silicon in the Foundry (Ueber Verwendung hochprozentigen Ferrosiliziums in der Eisengiesserei). Dr. Westhoff. Its utility, effects on cast iron, cost, etc. 2000 w. Stahl u Eisen—Aug. 26, 1908. No. 95135 D.

Foundry Practice.

Needless Foundry Wastes. Harrington Emerson. Read before the Am. Found. Assn. Considers preventable losses and wastes. 900 w. Foundry—Sept., 1908. No. 94715.

"Burning" a Propeller Wheel Blade. Thomas D. West. Read before Phila. Found. Assn. Illustrates and describes details of the operation. 1500 w. Ir Age—Sept. 10, 1908. No. 94903.

Open-Hearth Steel Foundry Practice. Illustrated description of the arrangement, equipment, and operating methods of a plant, containing one 15-ton acid furnace, at Lima, Ohio. 2000 w. Foundry—Sept., 1908. No. 94714.

Furnaces.

Applications of Oil Burning Apparatus. C. M. Ripley. A review of present methods. 1800 w. Sci Am Sup—Sept. 5, 1908. No. 94902.

Furnaces for the Enameling Industry. Joseph Vollkommer. Illustrated descriptions. 1500 w. Ir Age—Sept. 3, 1908. No. 94813.

A Tempering Furnace with Electrically Heated Bath (Ueber einen Härteofen mit elektrisch geheiztem Schmelzbad). C. R. Straube. Illustrated description of the A. E. G. furnace which employs three-phase current to fuse a salt varied according to the temperature required. 4500 w. Elektrotech Zeitschr—Aug. 6, 1908. No. 95187 D.

Grinding Machines.

Grinding Machine Troubles and Their Causes. A. B. Schleifer. 2500 w. Am Mach—Vol. 31, No. 36. No. 94830.

Grinding Machines and Their Applications (Schleifsscheiben und ihr Verwendungsgebiet). Alfred Lebert. Illustrates and describes machines for various classes of work. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 1908. No. 95-181 D.

Milling Machines.

Cincinnati High Power Milling Machines. Illustrates and describes a series of machines built on the unit system. 4500 w. Am Mach—Vol. 31, No. 38. No. 95206.

New Le Blond Milling Machine Attachments. Illustrated descriptions of a number of attachments, including one for hobbing gears. 2000 w. Ir Age—Sept. 3, 1908. No. 94811.

Molding.

The Permanent Mold Problem. Edgar Allen Custer. Considers the difficulties in the art of making castings in permanent iron molds and how they have been overcome. 1500 w. Foundry—Sept., 1908. No. 94717.

Molding Machines.

Molding Machines (Machines à Mouler). M. Avaurieu. Illustrated description of the design and operation of types which have appeared during the last four years. Serial. 1st part. 6500 w. Rev de Mécan—Aug., 1908. No. 95106 E + F.

Molding Sand.

The Mechanical Preparation of Molding Sand (Le Sabbie da Fonderia e la loro Preparazione Meccanica). Aureli Aurelio. Illustrates and describes methods and machines for drying, disintegrating, etc. Serial, 1st part. 2500 w. Monit Tech—Aug. 20, 1908. No. 95120 D.

Patterns.

The Classification of Patterns. Oscar E. Perrigo. Illustrated discussion of various molding processes and their relation to pattern-making. 4000 w. Foundry—Sept., 1908. No. 94719.

Pneumatic Hammers.

New Pneumatic Hammers with Separate Hammer and Air-Pump Cylinders (Neuere Lufthämmer mit getrenntem Bär- und Luftpumpenzylinder). Herm. Meyer. Illustrated description of various types. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 22, 1908. No. 95-184 D.

Sawing Machines.

5-in. Hack-Sawing Machine. Illustrated description of a machine shown at the Franco-British exhibition. 500 w. Engng—Sept. 11, 1908. No. 95086 A.

We supply copies of these articles. See page 326.

Shop Appliances.

Some Old Gages and Filing Jigs. E. A. Dixie. Illustrations and information. 1500 w. Am Mach—Vol. 31, No. 37. No. 94921.

Profitable Methods in Metal Working (Vorteilhafte Arbeitsverfahren für Metallbearbeitung). H. Baessler. Describes methods, tools, and machines found useful by the writer. Ills. Serial. 1st part. 3300 w. Zeitschr d Ver Deutscher Ing—Aug. 1, 1908. No. 95177 D.

Shop Design.

Design and Construction of Metal Working Shops. W. P. Sargent. Discusses industrial plant extension as applied to metal working industries. Ills. 4500 w. Mach, N Y—Sept., 1908. Serial. 1st part. No. 94800 C.

Shop Heating.

Heating and Ventilating a Sheet Metal Shop. Illustrated description of a fan system delivering air near floor level. 1300 w. Metal Work—Sept. 12, 1908. No. 94963.

Heating the McKees Rocks Shops, Pittsburgh & Lake Erie R. R. Douglas P. Morrison. Describes the system of heating 8 shops. 1200 w. Eng Rec—Sept. 5, 1908. No. 94870.

Shop Practice.

Machining a Large Segmental Gear Wheel. C. Scholtka. Illustrates and describes methods and operations. 1500 w. Am Mach—Vol. 31, No. 39. No. 95326.

The Manufacture of Wood-Working Machinery. Illustrated description of shops at Rochester, N. Y., and the arrangements of departments. 2500 w. Ir Trd Rev—Sept. 10, 1908. No. 94974.

Points of Interest in a Railroad Shop. Ethan Viall. Illustrated description of some of the tools and methods in use in the Chicago & Alton shops, at Bloomington, Ill. 2000 w. Am Mach—Vol. 31, No. 38. No. 95207.

Shops.

Engineering Works in the Manchester District. The present number illustrates and describes the works of Messrs. Galloways, Ltd., and Messrs. Frank Pearn & Co., Ltd. 2500 w. Elec Engr, Lond—Sept. 4, 1908. Serial. 1st part. No. 95039 A.

Shop Ventilation.

Industrial Dust and Disease. Reviews a discussion at the Sheffield meeting of the British Medical Assn. 1200 w. Engr, Lond—Sept. 4, 1908. No. 95055 A.

Tempering.

Hardening Steel. E. R. Markham. Describes methods used by writer, calling attention to harmful effects and practice. Ills. 4000 w. Mech Wld—Aug. 28, 1908. No. 94929 A.

A New Design for Hardening Rooms. E. F. Lake. Illustrated detailed description of room designed and equipped for the Standard Tool Co. of Cleveland, O. 2500 w. Am Mach—Vol. 31, No. 36. No. 94829.

See also Furnaces, under MACHINE WORKS AND FOUNDRIES.

Welding.

A Fusion Process for Welding Steels. Illustrates and describes a process that appears to be successful. 2000 w. Ir & Coal Trds Rev—Aug. 28, 1908. No. 94960 A.

New Thermit Reactions. Hans Goldschmidt. Demonstrates some new thermit reactions, the main feature of which is the substitution of other metals for aluminium. 3000 w. Elec-Chem & Met Ind—Sept., 1908. No. 94722 C.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

Special Alloy Steels and Their Mechanical Applications. Léon Guillet. Gives a summary of the present state of the art in France. 5000 w. Engineering Magazine—Oct., 1908. No. 95397 B.

Bearing Metals.

Bearings and Bearing Metals. L. Parry. Considers the properties sought for in white bearing metal, lubrication, etc. 3500 w. Min Jour—Aug. 22, 1908. No. 94778 A.

Breakages.

The Study of Breakages. Walter Rosenhain. Read before the British Assn. at Dublin. A plea for the thorough investigation of failures in engineering practice, describing in detail various examples, and discussing causes. Ills. 7500 w. Engng—Sept. 11, 1908. No. 95088 A.

Cast Iron.

Effects of Titanium on Cast Iron. Condensed from an article by Bernhard Feise, in *Stahl und Eisen*. 900 w. Ir Age—Sept. 10, 1908. No. 94905.

Gaskets.

A Practical Consideration of Gaskets. W. E. Sanders. Discusses the essentials of a good gasket, and the proper method of cutting them. 3500 w. Power—Sept. 22, 1908. No. 95250.

Packings.

The Purchase and Use of Packing. W. E. Sanders. Considers economy, cutting, lubricating, etc. 2500 w. Power—Sept. 15, 1908. No. 95061.

"Moisture" and "Expansion" Packings. W. E. Sanders. Describes the packings, especially the manufacture of rubber packings. Ills. 2500 w. Power—Sept. 1, 1908. No. 94747.

Automatic Steam and Ammonia Packings. W. E. Sanders. A discussion of the advantages, cost, and application of diagonal or automatic packings, and of packings for high temperatures and ammonia. 2500 w. Power—Sept. 8, 1908. No. 94908.

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Steel.

Magnet Steel (Magnetstahl). G. Hannack. Discusses the physical properties of good magnet steel and the influence of various impurities and alloys. Ills. 1800 w. Stahl u Eisen—Aug. 26, 1908. No. 95134 D.

Tool Steels.

High-Speed Steel. H. H. Hill. Read befort the Liverpool Engng Soc. Considers recent advances made in tool steels and their application. 2000 w. Mech Wld—Aug. 21, 1908. No. 94765 A.

Wastes.

The Utilization of Industrial Wastes (La Mise en Valeur des Déchets Industriels). Paul Bellou. A general paper on the mechanical and chemical methods of effecting a separation of mixed refuse. Ills. 6000 w. Rev d'Econ Indus—Aug., 1908. No. 95100 D.

MEASUREMENT.

Cooling Curves.

On Methods of Obtaining Cooling Curves. G. K. Burgess. Discusses methods of thermal analysis, temperature-time curves, differential curves, direct and inverse rate curves, rapid cooling, and characteristics of cooling curves. Ills. 5500 w. Elec-Chem & Met Ind—Sept., 1908. Serial. 1st part. No. 94724 C.

Extensometers.

The Use of an Extensometer in Commercial Work. T. D. Lynch. Presents stress-strain diagrams on steel and other metals in tension, showing the comparative elasticity. 2500 w. Eng Rec—Sept. 12, 1908. No. 94970.

Hardness.

Instrument for Testing Hardness. J. F. Springer. Illustrates and describes the scleroscope and its use. 1000 w. Ry & Loc Engng—Sept., 1908. No. 94827 C.

Methods of Testing Materials for Hardness. J. F. Springer. An illustrated article comparing the ball, electric and drop methods. 5500 w. Cassier's Mag—Sept., 1908. No. 94733 B.

The Brinell Method of Testing the Hardness of Metals. Explains the principle of the method devised by J. A. Brinell, which consists in partly forcing a steel ball into the material to be tested. 2000 w. Mach, N Y—Sept., 1908. No. 94801 C.

Pyrometry.

Cold-Junction Temperature Corrections of Pt. Pt Rh and Pt. Pt Ir Thermo-Electric Pyrometers. Cornelius Offerhaus and Ernst H. Fischer. Discusses the measuring of temperatures by means of thermocouples. 2800 w. Elec-Chem & Met Ind—Sept., 1908. No. 94723 C.

The Wanner Optical Pyrometer for Temperatures Between 625 and 1000 degrees C. (Das optische Pyrometer Wanner für Temperaturen von 625°-1000° C.). Illustrated detailed description of construction and operation. Serial. 1st part. 1500 w. Elektrochem Zeitschr—Aug., 1908. No. 95128 D.

See also Cooling Curves, under MEASUREMENT.

POWER AND TRANSMISSION.

Air Compressors.

A Variable Volume Air Compressor. H. V. Haight. Illustrated description of a duplex-tandem machine which varies the delivery by quarter loads while maintaining full compound efficiency. 1000 w. Compressed Air—Sept., 1908. No. 94818.

An Improved Hydraulic Air Compressor System. George C. McFarlane. Illustrates and describes the system, giving details of construction of air tanks, pipes and nozzle. 1000 w. Min Wld—Sept. 19, 1908. No. 95210.

Belts.

The Use of Jockey-Pulleys on Belts. Illustrated description of the "Lenix" belt drive. 1500 w. Mech Wld—Sept. 4, 1908. No. 95036 A.

Chain Driving.

Chain Drive for Automatic Forming Machines. Explains the advantages of this smooth and positive spindle drive. Ills. 1500 w. Am Mach—Vol. 31, No. 38. No. 95208.

Electric Driving.

Two-Motor Drive—Automatic Web Printing Press Control. S. H. Sharpsteen. Diagram and description. 3500 w. Elec Rev, N Y—Sept. 19, 1908. No. 95213.

The Dynamic Brake in Printing Press Drive. S. H. Sharpsteen. Discusses dynamic brake troubles. 1500 w. Elec Wld—Sept. 19, 1908. No. 95218.

The Storage Battery for Web Printing Press Control. S. H. Sharpsteen. Describes a method of control that uses no resistance in circuit with the armature. 2000 w. Elec Wld—Sept. 12, 1908. No. 95017.

The Application of Motors to Machine Tools. Dexter S. Kimball. Explains the advantages and discusses methods. 4000 w. Wood Craft—Sept., 1908. No. 94819.

An Electrically-Operated Gas Plant. Dr. Alfred Gradenwitz. Illustrations and description of a plant in Germany. 800 w. Sci Am Sup—Sept. 26, 1908. No. 95339.

Gas Compressors.

Gas Compressors of Special Type. Silas R. Stone. Illustrated description of a type built for special service. 800 w. Power—Sept. 8, 1908. No. 94912.

Hydraulic Power.

Modern Hydraulic Power Stations. N. S. Trustrum. Shows that there is still use for hydraulic power, and considers the means of transmission. 1500 w. Prac Engr—Sept. 11, 1908. Serial. 1st part. No. 95274 A.

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Lubrication.

Piping Oil to Several Hundred Machines. Illustrates and describes methods used by the Standard Tool Co., of Cleveland, O., for overcoming the clogging of pipes with chips by means of open gutters and filters. 1000 w. Am Mach—Vol. 31, No. 37. No. 94919.

See also Bearing Metals, under MATERIALS OF CONSTRUCTION.

Power Plants.

Practical Notes on Gas Engine Driven Dynamos. Discusses the causes that are liable to give trouble. 2500 w. Mech Wld—Aug. 21, 1908. No. 94763 A.

STEAM ENGINEERING.

Boiler Cleaning.

Cleaning Babcock and Wilcox Boilers. Percival Hastings. Directions and suggestions, 1200 w. Power—Sept. 22, 1908. No. 95251.

Boiler Design.

Calculating the Strength of New Steam Boilers (Sterkteberekening van nieuwe Stoomketels). A report of a commission to the Dutch Minister for the Colonies. An exhaustive discussion. Tables. Curves. Ills. 18000 w. De Ingenieur—Aug. 22, 1908. No. 95195 D.

Boiler Efficiency.

The Real Efficiency of Steam Boilers. W. H. Booth. On methods of computing efficiency, and the errors. 2200 w. Power—Sept. 1, 1908. No. 94749.

Boiler Explosions.

See Boiler Scale, under STEAM ENGINEERING.

Boiler Houses.

Standard Boiler House Design of the Oliver Iron Mining Co. A. M. Gow. Read at meeting of the Lake Superior Min. Inst. Explains conditions to be met and considers in detail the design adopted. Ills. 5000 w. Eng News—Sept. 17, 1908. No. 95221.

Boiler Management.

Modern Steam Boiler Practice. W. H. Booth. Discusses points in boiler practice which affect the efficiency. 2500 w. Elec Rev, Lond—Sept. 4, 1908. No. 95042 A.

Management and Design of Lancashire and Cornish Boilers. Vernon Smith. Directions for their care and discussion of sources of trouble in the present number. 2000 w. Prac Engr—Sept. 4, 1908. Serial. 1st part. No. 95032 A.

Boiler Scale.

Corrosion and Incrustation—A Source of Boiler Explosions. Illustrates and describes a number of instances of scale formation, showing its harmful effects. 2200 w. Boiler Maker—Sept., 1908. No. 94805.

Boiler Tests.

See Steam Calorimetry and Stokers, under STEAM ENGINEERING.

Boiler Theory.

The Influence of Velocity of Furnace Gas on the Rate of Heat Transfer. F. Kingsley. Examines theories of boiler heating and gives conclusions. 1600 w. Eng Rec—Sept. 5, 1908. No. 94869.

Boiler Waters.

A Large Oil Eliminating Plant. Illustrates and describes the plant at Summer Lane station of the Birmingham Corporation, which is believed to be the largest of its kind. 1500 w. Engr, Lond—Sept. 4, 1908. No. 95059 A.

Boilers and Boiler Compounds. C. N. Chubb. Deals with the economical operation of steam boilers, irrespective of the fuel used, and with their proper care and maintenance. Discussion. 5000 w. Pro Age—Sept. 1, 1908. No. 94799.

Condensers.

A Note on Condensation. Maurice Leblanc. Translation of paper read before the Assn. Tech. Mar., Paris. Discusses the requirements of condensers for steam turbines. 8000 w. Engng—Aug. 28, 1908. No. 94952 A.

Engine Breakdowns.

The Prevention of Steam Engine Breakdowns. H. S. Knowlton. Notes from reports of large casualty companies, showing where improvements are needed. Ills. 1800 w. Power—Sept. 8, 1908. No. 94910.

Steam Engine Breakdowns and Their Lessons. Michael Longridge. From the annual report of the Chief Engineer of the British Engine, Boiler and Elec. Ins. Co., Ltd., for 1907. Ills. 6000 w. Mech Engr—Sept. 11, 1908. No. 95277 A.

Engines.

280 H. P. Superheated Steam Side-by-Side Compound Condensing Engine. Illustrated description of the latest design of the Schmidt superheated steam engine. 2500 w. Engng—Aug. 28, 1908. No. 94951 A.

Engine Tests.

Economy Tests of High Speed Engines. Discussion of the paper by Messrs. Dean and Wood. 4500 w. Jour Am Soc of Mech Engrs—Sept., 1908. No. 95073 F.

Entropy.

On the Meaning and Use of Entropy. William McEntee. A discussion of the fundamental principles on which considerations of fuel economy are based where heat is made to do mechanical work. 2000 w. Pro U S Nav Inst—Sept., 1908. No. 95270 F.

Fuel Oil Storage.

A Modern Fuel Oil Storage System. H. W. Beecher. Describes the system installed at Redondo, Cal. 1200 w. Min & Sci Pr—Sept. 19, 1908. No. 95350.

Fuels.

Liquid Fuel. Charles L. Hubbard. Reviews the advantages and disadvantages.

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1600 w. Power—Sept. 8, 1908. No. 94913.

The Use of Natural Gas in the Joplin District. Doss Brittain. Describes methods of using gaseous fuel in boiler plants and compares the economy of the steam engine and the internal combustion motor. Ills. 2500 w. Eng & Min Jour—Sept. 19, 1908. No. 95245.

Coal Tests at McGill University. A report of the investigations made by the Canadian Department of Mines. 2500 w. B C Min Rec—July, 1908. No. 95322 B.

Purchase of Coal on Specifications. J. E. Woodwell. Gives results of recent experiences in the purchase of coal for the Treasury and other departments of the Government through the application of the Government specification. 2400 w. Pro Age—Sept. 15, 1908. No. 95082.

The Modification of Illinois Coal by Low Temperature Distillation. S. W. Parr and C. K. Francis. Preliminary report of a series of experiments, having in mind such a change in the chemical composition of coal as would modify or minimize the production of smoke. Ills. 10700 w. Univ of Ills, Bul 24—June 22, 1908. No. 95065 N.

Laboratories.

The Establishment of Steam Engineering Laboratories in Germany and their Utility for Austria (Ueber die Einrichtung feuerungs- und dampftechnischer Versuchsanstalten im Deutschen Reiche und ihre Nutzanwendung für Oesterreich). Oskar Friedmann. Describes the plants and their work. Ills. 2500 w. Oest Zeitschr f d Oeffent Baudienst—Aug. 15, 1908. No. 95165 D.

Plant Management.

Economic Considerations on the Management of Plant. W. H. Patchell. Suggestions in regard to water, fuel and many possible economies. 4000 w. Public Works—July-Sept., 1908. No. 95318 B.

Steam Calorimetry.

The Quality of Steam. W. D. Spooner. Explains the principle of action of the throttling calorimeter, and the barrel calorimeter. Ills. 1800 w. Power—Sept. 1, 1908. No. 94748.

Steam Pipes.

Hangers and Supports for Piping Systems. William S. Fischer. Illustrates and describes various arrangements, 600 w. Power—Sept. 22, 1908. No. 95252.

The Piping Systems of High Pressure Plants. Charles L. Hubbard. Directions for arranging steam and water piping. Ills. 3500 w. Power—Sept. 22, 1908. No. 95248.

Steam Temperature.

The Regulation of the Temperature of Steam and the Jankovsky Regulator (Die Regulierung der Dampftemperatur und der Jankovsky-Regler). Sigmund Bourdot. Illustrated description of construction and details of operation. 1600 w. Elektrotech Rundschau—Aug. 20, 1908. No. 95167 D.

Stokers.

A Boiler Test, Showing Efficient Mechanical Stoking. R. T. Coe. Illustrated article calling attention to details of the Lardner's Point pumping station at Tacony, Pa., and giving a record of an interestng test made of the mechanical stoking equipment. 1200 w. Ir Age—Sept. 17, 1908. No. 95204.

Superheating.

Thermal Properties of Superheated Steam. Discussion of paper by R. C. H. Heck. 3000 w. Jour Am Soc of Mech Engrs—Sept., 1908. No. 95072 F.

Steam Superheaters and Their Applications. W. H. Watkinson. Read before the Liverpool Engng. Soc. Discusses the advantages derived from the use of superheated steam with stationary and locomotive boilers. 2500 w. Mech Wld—Aug. 28, 1908. No. 94930 A.

Thermodynamics.

Historical Review of the Theory of Heat Engines. Dugald Clerk. Presidential address to the Engineering Section of the British Assn. 4800 w. Mech Engr—Sept. 4, 1908. Serial. 1st part. No. 95035 A.

Turbine Accidents.

A Turbine Runaway. T. J. Walsh. An account of an accident at Woonsocket, R. I. 1000 w. Elec Wld—Sept. 5, 1908. No. 94841.

Turbine Plants.

Double Deck Turbine Power Plants. A résumé of the most characteristic features of the double deck station. Ills. 2000 w. Elec Jour—Sept., 1908. No. 95067.

Turbines.

Steam Turbines in Power Stations. Harry Webber. Facts in connection with the running and maintenance of turbines of the Parsons type. 2500 w. Elec Rev, Lond—Sept. 4, 1908. No. 95040 A.

Recent Advances in Steam Turbines. Gerald Stoney. Read before the British Assn, at Dublin. Shows the rapid progress of the steam turbine and its applications. 3000 w. Elec Engr, Lond—Sept. 11, 1908. No. 95278 A.

Steam Turbine Development. J. C. Thorpe. A collection and discussion of facts recently learned. Ills. Discussion. 11000 w. Jour W Soc of Engrs—Aug., 1908. No. 95391 D.

The First American Steam Turbine. F. E. Drake. An illustrated account of the "Bailey Jack," patented by a New Englander more than 100 years ago. 1000 w. Power—Sept. 1, 1908. No. 94751.

See also Stuffing Boxes, under MACHINE ELEMENTS AND DESIGN.

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Turbine Tests.

New Steam Turbine Tests (Einige neue Versuche an Dampfturbinen). F. Marguerre. Reports tests on a 1000 k. w. Parsons turbine. Ills. 4400 w. Zeitschr d Ver Deutscher Ing—Aug. 22, 1908. No. 95185 D.

Valve Gears.

An Exact Method of Slide Valve Design. Frank W. Merrill. Explains the use of the valve diagram and a study of the exact relations between rotary and reciprocating motions. 4000 w. Power—Sept. 22, 1908. No. 95253.

TRANSPORTING AND CONVEYING.

Cableways.

Ropeway at a Colliery. Illustrates and describes a ropeway on the endless running rope system, constructed where no other means of transport would have been possible. 600 w. Engr, Lond—Aug. 21, 1908 No. 94789 A.

Coal Handling.

See Docks, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Conveyors.

Simple Forms of Coal and Ash Conveyors. Warren O. Rogers. Illustrates and describes several types. 1200 w. Power—Sept. 1, 1908. No. 94746.

The Conveying of Materials. Discussion of five papers given at Detroit, on the hoisting and conveying of materials. Ills. 10000 w. Jour Am Soc of Mech Engrs—Sept., 1908. No. 95071 F.

Performance of Belt Conveyors. Edwin J. Haddock. A report of experiments made with this form of conveyor. 2000 w. Jour Am Soc of Mech Engrs—Sept., 1908. No. 95068 F.

Dock Machinery.

The Relative Advantage of Hydraulic and Electric Power for Port and Dock Work. Brysson Cunningham. An illustrated comparison of power transmission methods. 3000 w. Cassier's Mag—Sept., 1908. No. 94736 B.

Elevators.

The Plunger Hydraulic Elevator. William Baxter, Jr. Describes the construction of passenger elevators of this type. Ills. 1600 w. Power—Sept. 8, 1908. Serial. 1st part. No. 94911.

MISCELLANY.

Aeronautics.

The Wreck of the "Zeppelin IV." Brief illustrated accounts of the disaster. 1000 w. Sci Am Sup—Sept. 5, 1908. No. 94901.

The Improved Parseval Airship. Illustrated description of Germany's non-rigid military dirigible. 800 w. Sci Am Sup—Sept. 26, 1908. No. 95341.

The Construction of the Wright Aeroplane. Illustrates and describes the constructional details. 2000 w. Sci Am—Sept. 26, 1908. No. 95338.

The "Mystery" of the Wrights. A discussion of the claims of the Wright Brothers, and of what they have accomplished. Ills. 1700 w. Auto Jour—Aug. 22, 1908. No. 94760 A.

The First Flight of the Wright Aeroplane at Fort Myer. A brief illustrated account. 700 w. Sci Am—Sept. 12, 1908. No. 94993.

How Orville Wright Made His Flights. E. Percy Noel. An illustrated account of flights at Fort Myer, Va. 2000 w. Automobile—Sept. 17, 1908. No. 95099.

Soaring Flight. Marcel Deprez. Illustrates and describes models for its mechanical investigation. 1500 w. Sci Am Sup—Sept. 12, 1908. No. 94995.

The Problem of Aerial Navigation. Prof. Simon Newcomb. An inquiry as to what measure of rational hope we can entertain that aerial flight will serve some practical purpose in the world's work. 6500 w. Nineteenth Century—Sept., 1908. No. 95074 D.

The Laws of Flight. F. W. Lanchester. Read before the British Association for the Advancement of Science at Dublin. Considers information obtained by observation and experiment, explaining the theory of flight developed by the author. 3000 w. Engr, Lond—Sept. 18, 1908. Serial. 1st part. No. 95414 A.

Exhibitions.

The Prague Jubilee Exhibition, 1908. Describes this exhibition in Bohemia and the exhibits. Ills. Engr, Lond—Aug. 28, 1908. Serial. 1st part. No. 94954 A.

Mechanical Features of the Franco-British Exhibition. An illustrated critical review of the engineering exhibits. 3500 w. Cassier's Mag—Sept., 1908. No. 94737 B.

The Franco-British Exhibition (L'Exposition Franco-Britannique de Londres, 1908). E. Lemaire. Discusses the attractions and exhibits from the French point of view. Ills. 5600 w. Génie Civil—Aug. 1, 1908. No. 95112 D.

Flour-Milling Machinery.

Flour Milling Machinery. The present number deals with the reception, cleaning and storing of grain. Ills. 4500 w. Engng—Sept. 4, 1908. Serial. 1st part. No. 95051 A.

Sugar Factories.

Cane Sugar Factories. Cyril W. Dawson. Deals with the chief problems in connection with such factories. 2500 w. Engr, Lond—Aug. 21, 1908. Serial. 1st part. No. 94791 A.

Textile Machinery.

Features of the "Ideal" Automatic Loom. Illustrates and describes features in the design, operation and manufacture of the latest development in automatic cotton weaving looms. 4500 w. Am Mach—Vol. 31, No. 39. No. 95327.

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MINING AND METALLURGY

COAL AND COKE.

Alberta.

Taber Plant of the Canada West Coal Co., at Taber, Alberta. Methods of constructing concrete buildings in a Canadian winter are illustrated and described. 2500 w. Mines & Min—Sept., 1908. No. 94809 C.

Coal Cutting.

Coal Cutting Machinery. Allan R Connal. Brief consideration of the use of coal cutters in Great Britain, especially the electric cutters. 1200 w. Elec Rev, Lond—Aug. 21, 1908. No. 94768 A.

The Operation of Coal Cutting Machinery. George E. Lynch. A discussion of the use and economy of various coal cutters, showing the advantages and disadvantages of each type. 2500 w. Eng & Min Jour—Sept. 12, 1908. No. 94991.

Coke Ashes.

The Variable Color of Coke Ashes. W. P. Young. A résumé of experiments to determine the cause. 1200 w. Eng & Min Jour—Sept. 12, 1908. No. 94992.

Coke Ovens.

The By-Product Coke Oven. Discussion of paper by W. H. Blauvelt. 3500 w. Jour Am Soc of Mech Engrs—Sept., 1908. No. 95070 F.

By-Product Coke Ovens. Abstract of a report of R. Forbes Carpenter, chief inspector under the Alkali works act. 3500 w. Col Guard—Sept. 4, 1908. Serial. 1st part. No. 95049 A.

Mechanical Levelling Machines (Ueber mechanische Planiervorrichtungen). A. Thau. Illustrated description of various appliances for levelling off the charge in coke ovens. 2000 w. Glückauf—Aug. 8. 1908. No. 95140 D.

Coking By-Products.

New Method of Obtaining Sulphate of Ammonia. R. S. Moss. Describes improvements in the Kopper system. Ills. 2000 w. Min Wld—Sept. 19, 1908. No. 95211.

Coking Plants.

New By-Product Coke Plant at Joliet, Ill. Illustrates and describes the first installation of Kopper's ovens in America. Plate. 2800 w. Ir Trd Rev—Sept. 3, 1908. No. 94843.

Electric Power.

The Electric Plant at the Mines of the König Ludwig Company, Recklinghausen (Die elektrischen Anlagen auf den Zechen der Gewerkschaft König Ludwig in Recklinghausen). Kurt Perlewitz. Illustrated detailed description. Serial. 1st part. 1600 w. Elektrotech Zeitschr—Aug. 20, 1908. No. 95191 D.

Some Applications of Electric Power in Belgium (Quelques Applications de l' Electrotechnique en Belgique). Alfred Lambotte. The fourth part of the serial describes the installations of the Société anonyme des Charbonnages de Ham-sur-Sambre et Moustier. Ills. 7500 w. Soc Belge d'Elecns—Aug., 1908. No. 95101 E.

Explosions.

Report on the Washington "Glebe" Colliery Explosion. Report of the inspector of mines on the explosion in the county of Durham, on Feb. 20, 1908. Ills. 8500 w. Col Guard—Aug. 21, 1908. No. 94780 A.

Dust Explosion at Minneapolis, May 2, 1878, and Other Dust Explosions. S. F. Peckham. Extract from report of Prof. Peckham and Prof. Peck, of experiments of interest in connection with dust explosions in mines. Ills. 4500 w. Mines & Min—Sept., 1908. No. 94807 C.

Explosives.

Recent Researches on the Use of Explosives in the Presence of Gas and Coal Dust (Nouvelles Recherches sur l'Emploi des Explosifs en Présence du Grison et des Poussieres de Charbon). H. Schmerber. The first part reviews Herr Bichel's investigations at Schlebusch. Ills. Serial. 1st part. 2500 w. Génie Civil—Aug. 15, 1908. No. 95115 D.

Germany.

The Development of the Rhine Lignite Industry and its Importance to the Domestic Fuel Supply of West and South Germany (Die Entwicklung der rheinischen Braunkohlenindustrie und ihre Bedeutung für die Hausbrandversorgung des westlichen und südlichen Deutschlands). H. E. Böker. Ills. 5600 w. Serial. 1st part. Glückauf—Aug. 22, 1908. No. 95142 D.

Holland.

The Results of New Deep Bore Holes in Eastern Holland (Die Ergebnisse der neuern Tiefbohrungen in östlichen Holland). Dr. Ahlburg. An account of the strata and coal measures encountered. Ills. 9500 w. Glückauf—Aug. 22, 1908. No. 95141 D.

India.

Mining in India in 1907. Reviews the report of J. R. R. Wilson, Chief Inspector of Mines in India. 3000 w. Ir & Coal Trds Rev—Sept. 11, 1908. No. 95295 A.

Mine Dust.

Experiments with Coal Dust at the Home Office Testing Station. A report of experiments made to determine whether all coal dusts are to be regarded

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as dangerous. 3500 w. Ir & Coal Trds Rev—Aug. 28, 1908. No. 94961 A.

British Coal Dust Experiments. An account of experiments recently carried out to test the explosive qualities of coal dust, and its capacity for intensifying the effect of explosives in mines. Ills. 7000 w. Col Guard—Aug. 28, 1908. Serial. 1st part. No. 94945 A.

Coal Dust and Colliery Explosions. V. Wattegue, in *An. des Mines de Belgique.* Reviews the conditions observed in the Courrieres pit after the accident there, and also the explosion at La Boule pit in 1887. Ills. 1500 w. Col Guard—Aug. 28, 1908. No. 94946 A.

Mine Gases.

The Composition and Physiological Effects of Black Damp. From *The Science and Art of Mining.* A report of research work, giving conclusions. 2000 w. N Z Mines Rec—July 16, 1908. No. 95342 B.

Mine Ventilation.

An Improved System for Ventilation of Mines. W. E. Elliot and J. G. Wilson. Illustrated description of a system that makes it possible to flood a mine in case of fire. 1500 w. Min Wld—Sept. 5, 1908. No. 94891.

Mining.

Operation of Carmaux Coal Mines in France. Lucius W. Mayer. Illustrates and describes a system of mining thick seams in slices. 4000 w. Eng & Min Jour—Sept. 19, 1908. No. 95246.

Peat.

Peat and Lignite. A review of the Canadian Government report on their future. 2000 w. Elev Rev, Lond—Sept. 4, 1908. No. 95041 A.

The Utilization of Peat. H. Riall Sankey. Read before the British Assn, at Dublin. Considers its use for making gas or charcoal, with recovery of by-products. Ills. 8500 w. Engng—Sept. 11, 1908. No. 95093 A.

Some Notes on the Development of the Peat Fuel Industry and Its Possibilities. Ernest V. Moore. Reviews the attempts made to utilize these deposits, showing why they have been unsuccessful, and how success may be attained. Ills. Discussion. 15000 w. Can Soc of Civ Engrs, Bul No 3—May., 1908. No. 95367 N.

Pennsylvania.

Coal Mining in Southern Anthracite Field. Thomas F. Downing. Describes methods used where seams are gaseous, and conditions very different from the northern field. 2500 w. Eng & Min Jour—Sept. 5, 1908. No. 94880.

Rescue Appliances.

Rescue Appliances in Modern Mining (Das Rettungswesen im modernen Bergbaubetriebe). Friedrich Okorn. A general discussion of breathing apparatus and rescue methods. Serial. 1st part. 2000 w. Oest Zeitschr f Berg-u Huttenwesen —Aug. 1, 1908. No. 95136 D.

Wales.

Geological Features of the Red Seam at Clydach Vale. David Davies. Illustrates and describes the plant life and gives conclusions concerning the formation, climate, etc. 3500 w. Ir & Coal Trds Rev—Aug. 21, 1908. No. 94793 A.

Washing.

Chemical Control of Coal Washers. Randolph Bolling. Illustrates and describes methods used by the Nova Scotia Steel & Coal Co. 1000 w. Eng & Min Jour—Aug. 29, 1908. No. 94706.

Dust-Separating Devices at the Mines of the Ruhr District (Vorrichtungen zum Abscheiden von Kohlenstaub auf den Zechen des Ruhrkohlenreviers). Herr Hasebrink. Illustrated description. 3500 w. Glückauf—Aug. 29, 1908. No. 95143 D.

COPPER.

Alaska.

Some Notes on the Copper River District, Alaska. William M. Brewer. Information obtained on a personal visit to this district concerning the conditions, ore deposits, etc. 3500 w. B. C. Min Rec—July, 1908. No. 95321 B.

Australia.

Copper Mining in South Australia. Reginald F. Barker. Remarks on the mines of the northern districts. 2500 w. Aust Min Stand—Aug. 12, 1908. No. 95371 B.

California.

Mining and Smelting on Shasta Copper Belt. Al. H. Martin. Describes these deposits in California, the methods of mining, smelting, etc. Ills. 2500 w. Min Wld—Aug. 29, 1908. No. 94709.

Costs.

Official Reports of Costs of Producing Copper. Arthur R. Townsend. A comparison of tabulated statements of costs of mining, smelting, transportation and administration from reports of 22 companies. 4000 w. Eng & Min Jour—Sept. 19, 1908. No. 95242.

Lake Superior.

Ontonagon County Mines: Past and Present. Robert H. Manerer. Explains recent activities caused by the remarkable find of the "Lake" lode on an abandoned property. 2200 w. Min Wld—Aug. 29, 1908. No. 94711.

Mexico.

Some Notes from the Cananea Copper Field. Charles A. Dinsmore. Illustrates and describes the method of handling ore and the reduction in cost of production. 1500 w. Min Wld—Sept. 12, 1908. No. 95022.

Refining.

Electrolytic Refining of Gold, Silver and

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Copper at the United States Mint, San Francisco, Cal. Robert L. Whitehead. Illustrated description of the recently installed equipment for electrolytic refining, which is said to be the most up-to-date plant. 3000 w. Elec-Chem & Met Ind—Sept., 1908. Serial. 1st part. No. 94721 C.

Smelters.

Douglas Smelting Works, Funidicion, Sonora. W. P. Tucker. Illustrated description of a new plant with mining and smelting costs. 800 w. Eng & Min Jour—Aug. 29, 1908. No. 94704.

Smelting.

Pyritic Smelting in Tilt Cove, Newfoundland. F. S. Nicholls. Gives early experiences in producing matte from pyritous ores without fuel. Ills. 1000 w. Eng & Min Jour—Sept. 5, 1908. No. 94877.

Washington.

The Copper Deposits of Lake Osoyoos, Wash. Horace F. Evans. Describes the geological features of extensive deposits. 2500 w. Min Wld—Sept. 5, 1908. No. 94892.

GOLD AND SILVER.

Alaska.

See Placers, under GOLD AND SILVER.

Cobalt.

Cobalt, Canada. Alex. Gray. Nipissing and La Rose mines are contrasted. 3500 w. Min Jour—Aug. 29, 1908. No. 94943 A.

Cobalt, Canada. Alex. Gray. Information concerning the Right-of-Way mine, and the La Rose mine, with general remarks on the mining camps. 3500 w. Min Jour—Aug. 22, 1908. No. 94775 A.

The Prospects of the Cobalt Central Company. Alex. Gray. An account of development work, etc. Ills. 2500 w. Min Wld—Sept. 12, 1908. No. 95025.

Property and Plant of Right-of-Way Company. Alex. Gray. Plan of underground workings with information concerning development, methods, etc. 1500 w. Min Wld—Sept. 5, 1908. No. 94890.

See also Concentration, under ORE DRESSING AND CONCENTRATION.

Colorado.

Mineral Prospects Around Death Valley. Robert E. Rinehart. Information concerning present conditions. Ills. 1500 w. Min & Sci Pr—Aug. 29, 1908. No. 94853.

Cyaniding.

Cyaniding Slime. E. B. Wilson. An illustrated article on different ways of treating slime. 3500 w. Mines & Min—Sept., 1908. No. 94808 C.

Dredging.

Dredging in the Yukon. T. A. Rickard. Data gathered by personal observation. Ills. 3000 w. Min & Sci Pr—Aug. 29, 1908. Serial. 1st part. No. 94852.

Improved English Gold Dredge in West Africa. Frank C. Perkins. Illustrates and describes the construction of gold dredges, comparing advantages in operation. 1200 w. Min Wld—Sept. 5, 1908. No. 94888.

Mexico.

Zacatecas, a Famous Silver Camp of Mexico. Claude T. Rice. An illustrated account, giving the history, geology and developments, etc., 4500 w. Eng & Min Jour—Aug. 29, 1908. No. 94701.

Pachuca and Real del Monte Silver District. Claude T. Rice. An account of construction work, mining and milling methods. The silver ore contains little gold. Ills. 5500 w. Eng & Min Jour—Sept. 12, 1908. No. 94989.

Placers.

Dry Placers of Northern Sonora. F. J. H. Merrill. Describes these formations and the methods of working. 1200 w. Min & Sci Pr—Sept. 12, 1908. No. 95095.

The Beach Placers of the South Pacific Coast. C. D. Irvine. Describes the deposits, the difficulties in recovering the gold, etc. 2000 w. Min Wld—Aug. 29, 1908. No. 94712.

The Gold Placers of Parts of Seward Peninsula. Compiled from the U. S. Geol. Survey reports by C. C. Longridge. An illustrated historical résumé of Alaska placer fields and their development. 6000 w. Min Jour—Aug. 29, 1908. Serial. 1st part. No. 94958 A.

Queensland.

The Etheridge Goldfield. W. E. Cameron. Maps and illustrated description of these gold fields, the geology, condition of mining, ore treatment, etc., 9500 w. Queens Gov Min Jour—July 15, 1908. No. 94817 B.

The Mount Morgan Gold Mining Co., Ltd. (Queensland). J. Bowie Wilson. An interesting account of the ore occurrence. 3000 w. Aust Min Stand—Aug. 12, 1908. Serial. 1st part. No. 95370 B.

Rand.

Inaugural Address by the President. R. G. Benington. On the progress of mining and metallurgical work on the Rand. 4000 w. Jour Chem, Met, & Min Soc of S Africa—July, 1908. No. 95037 E.

Costs and Profits on the Witwatersrand. James Ralph Finlay. Showing that the methods compare favorably with other fields where conditions are unsettled. 3000 w. Eng & Min Jour—Sept. 19, 1908. No. 95244.

The Genesis of the Rand Gold. Dr. F. W. Voit. A discussion of the theories on the origin of the gold, especially some points not generally known. Ills. 2200 w. Min Jour—Sept. 5, 1908. Serial. 1st part. No. 95048 A.

Refining.

See same title, under COPPER.

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Tasmania.

Gold Mining and Milling Practice in Tasmania. Ralph Stokes. Describes the geology and development and the conditions affecting the mining industry. Ills. 2500 w. Min Wld—Sept. 5, 1908. No. 94893.

IRON AND STEEL.

Assaying.

The Determination of the Nitrogen Contained in Iron and Steel (Sur le Dosage de l'Azote contenu dans le Fer et l'Acier). A. S. de Osa. A review of methods. 5500 w. Rev de Métal—Aug., 1908. No. 95103 E + F.

Australia.

Yampi Sound Iron Ore Deposits (Western Australia). W. D. Campbell. The location, geology and deposits are dealt with. 1200 w. Aust Min Stand—Aug. 12, 1908. No. 95368 B.

Blast-Furnace Charges.

See Blast Furnace Slag, under IRON AND STEEL.

Blast Furnace Plants.

A Furnace Plant with a History. Illustrated account of a furnace at Dunbar, Pa., where pig iron has been made continuously since 1791. 1000 w. Ir Trd Rev.—Sept. 10, 1908. No. 94975.

Blast Furnaces.

An Oval Blast Furnace. Illustrates and describes a furnace at Middlesborough, Eng. 600 w. Engr, Lond—Aug. 28, 1908. No. 94957 A.

The New Rebecca Furnace of the Kittaning Iron & Steel Mfg. Co. Illustrated description. 2500 w. Ir Trd Rev—Sept. 24, 1908. No. 95348.

The Shape of the Iron Blast Furnace. Henry M. Howe. Considers the factors that have determined the dimensions of the stack in the past and are likely to govern changes in the future. Ills. 4000 w. Eng & Min Jour—Sept. 12, 1908. No. 94987.

Blast-Furnace Slag.

Graphical Representation of the Composition of Blast Furnace Slags and Graphical Ore Mixture Calculations (Die Zusammensetzung der Hochofenschlacke in graphischer Darstellung. Graphische Möllerberechnung). W. Mathesius. Gives analysis of many slags and shows method of constructing slag diagrams. Ills. 10500 w. Stahl u Eisen—Aug. 5, 1908. No. 95129 D.

Electro-Metallurgy.

Electro-Metallurgy and Electric Furnaces. F. Louvrier. Abstract trans. from Bol. de la Sec. de Fomento. Classification and comparison of electric furnaces, electric manufacture of ferro-alloys, etc. 3000 w. Min Jour—Aug. 22, 1908. No. 94776 A.

Desulphurization of Steel in the Electric Furnace. Reviews an article by Dr. T. Geilenkirchen, in *Stahl und Eisen*, describing the elimination effected in the Heroult type of furnace. 1600 w. Engr, Lond—Sept. 4, 1908. No. 95058 A.

The Roechling-Rodenhauser Electric Furnace. Dr. B. Newman in *Stahl und Eisen*. Gives results of a study of a new electric furnace designed to use three-phase alternating current. Ills. 2500 w. Ir Age—Sept. 17, 1908. No. 95205.

The New Röchling-Rodenhauser A. C. Electric Furnace and Progress in the Production of Steel in the Electric Furnace Röchling-Rodenhausers neuer Drehstromofen und weitere Fortschritte in der Elektrostahlerzengung). Dr. B. Newmann. Describes the furnace, its operation and results obtained. Ills. Serial. 1st part. 3000 w. Stahl u Eisen—Aug. 12, 1908. No. 95130 D.

Ferro-Alloys.

See Electric Metallurgy, under IRON AND STEEL.

Germany.

The German Syndicates. Interesting information relating to their operations, taken from the report of Sir Francis Oppenheimer. 4000 w. Ir & Coal Trds Rev—Aug. 28, 1908. No. 94959 A.

Ingot Molds.

The Production of Ingot Molds. G. B. Waterhouse. Illustrated description of an improved method of molding which involves the use of collapsible cores. 1200 w. Ir Trd Rev—Sept. 17, 1908. No. 95201.

Italy.

The History of the Italian Iron Industry (L'Industria Siderurgica Italiana al Momento Attuale). Francesco Massarelli. A general and statistical review. Ills. Serial. 1st part. 4000 w. Industria—Aug. 2, 1908. No. 95121 D.

Moore-Heskett Process.

The Moore-Heskett Process for the Manufacture of Iron and Steel. Short description of recent improvements, with illustrations. 1500 w. Mech Engr—Aug. 28, 1908. No. 94931 A.

Scrap.

The Classification of Old Material. An analysis of prevailing practices in the scrap market. Also editorial. 9800 w. Ir Trd Rev—Sept. 3, 1908. No. 94842.

Steel Works.

The Equipment of the Mill Buildings of the Gary Steel Plant. Illustrated detailed description of unusually interesting features, particularly the power plant. 5500 w. Eng Rec—Sept. 26, 1908. No. 95381.

The Glengarnock and Ardeer Works of the Glengarnock Iron & Steel Co., Ltd. Illustrated description of works equipped for the production of steel joists, angles, ties, channels, rails, etc., 2200 w. Ir & Coal Trds Rev—Aug. 21, 1908. No. 94792 A.

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LEAD AND ZINC.

Lead Smelting.

Blast Furnace Gases in Silver-Lead Smeltng. T. S. Austen. A report of tests. 700 w. Min & Sci Pr—Sept. 12, 1908. No. 95097.

A Peruvian Lead Smelter. Lester W. Strauss. Describes the smelter at Vesubio, at an altitude of 1400 ft. above sea level. Ills. 2000 w. Min & Sci Pr—Sept. 12, 1908. No. 95096.

The Bag-House at Selby, California. James C. Bennett. Illustrated description of a reinforced concrete structure for large lead smelting works. 2500 w. Eng & Min Jour—Sept. 5, 108. No. 94875.

Mexico.

The Granadena Mines. S. F. Shaw. Information concerning these mines in Mexico. The ores are complex, carrying gold and silver. Ills. 2000 w. Min & Sci Pr—Sept. 19, 1908. No. 95352.

Zinc Smelting.

The Ferrites, Compounds of an Iron Acid. J. S. C. Wells. Gives a report of laboratory experiments showing that oxide of iron forms a number of insoluble salts when heated in contact with zinc oxide. 2000 w. Eng & Min Jour—Aug. 29, 1908. No. 94705.

MINOR MINERALS.

Antimony.

Treatment of Antimony Ore. E. Chatillon. Illustrates and describes the process invented by the author. 1000 w. Min Jour—Aug. 22, 1908. No. 94779 A.

Manganese.

Manganese Ores; Occurrence, Uses and Value. E. C. Harder. Extract from Min. Resources of U. S. A record of uses, prices and production. 1200 w. Min Wld—Sept. 5, 1908. Serial. 1st part. No. 94894.

Molybdenum.

Molybdenum Ores. Information from a bulletin recently issued by the Imperial Institute on the occurrence and uses of molybdenum ores. 1200 w. Mech Engr—Sept. 11, 1908. No. 95276 A.

Oil.

Extracting Oil from Boreholes. A description of the Leinweber process, recently installed at the Kryg oil field, in Austria. 1800 w. Sci Am Sup—Sept. 26, 1908. No. 95340.

On the Question of Regulating Naphtha Gushers. Ira M. Pitersky. Trans. from *Gorny Jour.* Considers the conditions governing the movement of a jet of liquid and applies the experience to oil wells. Ills. 1600 w. Min Jour—Aug. 29, 1908. No. 94944 A.

Salts.

See Electric Power, under MINING.

Vanadium.

The New Vanadium Deposit of Peru. Describes the deposit and gives analysis. 1200 w. Min Jour—Sept. 5, 1908. No. 95047 A.

MINING.

Blasting.

A Selective Electric Fuse Spitting Device. Robert N. Bell. Describes a device for selective firing of holes from a distance by means of electric current. Ills. 1200 w. Eng & Min Jour—Sept. 12, 1908. No. 94990.

Boring.

Brejcha's Improved System of Boring. W. Galloway. Illustrated description of a system involving certain improvements in the diamond drill and in some of the appliances used in connection with it. Explains the advantages. 2000 w. Col Guard—Sept. 11, 1908. No. 95290 A.

Costs.

Costs of Mining Quartz Pyride Gold Deposits. James Ralph Finlay. A study of the costs of mining and milling. 6000 w. Eng & Min Jour—Sept. 12, 1908. No. 94988.

Drills.

The Siemens-Schuckert Electric Percussion Drill in Tunnel Driving in the Ausseer Salt Mines (Die Slossschrämmaschine—System Siemens-Schuckert Werke—mit elektrischem Antriebe beim Streckenvortriebe am Ausseer Salzberge). Hans Vogl. Gives details of operation in numerous tables. Ills. Serial. 1st part. 2800 w. Oest Zeitschr f Berg u Hüttenwesen—Aug. 15, 1908. No. 95137 D.

Drill Steel.

Cruciform Steel for Machine Drills. E. P. Kennedy. On the advantages of all cruciform steel and cruciform chuck-bushings. 700 w. Min & Sci Pr—Sept. 19, 1908. No. 95351.

Economics.

The Economy of Winning Ore. W. H. Doherty. Deals with the getting and transporting of ore from face to mill 2500 w. Min Jour—Aug. 22, 1908. No. 94777 A.

Electric Power.

The Utilization of Electric Power in Salt Mines. H. R. Speyer. Explains the requirements for producing commercial salts, giving an illustrated description of the power house and electrical equipment of mines of the Harz Mountains. 4000 w. Elec Engng—Aug. 27, 1908. No. 94934 A.

The Electric Plant at the Friedrichshall Potash Mines at Sehnde, near Hannover (Die elektrischen Anlagen auf den Kaliwerken Friedrichshall, A. G., Sehnde bei Hannover). W. Phillippi. Illustrated description. 3500 w. Elek Kraft u Bahnen—Aug. 24, 1908. No. 95170 D.

See also D. C. Motors, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Hoisting.

A note on the Koepe Hoisting System

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(Note sur l' Extraction par le Système Koepe). A translation by M. Lecuir of an article by Herr Kaufhold, giving a mathematical demonstration of a proposed new method for determining the capacity of the Koepe hoisting system. Ills. 3000 w. Rev de Mécan—Aug., 1908. No. 95107 E + F.

Hoisting Engines.

The Notbohm-Eigemann Safety Apparatus for Winding Engines. Illustrated description of the apparatus and explanation of the principles of its construction. 2000 w. Ir & Coal Trds Rev—Aug. 28, 1908. No. 94962 A.

Mine Models.

Court-Maps and Models. T. S. Harrison and C. H. Zulch. Illustrated description of methods used for representing the workings of mines in court proceedings. 4000 w. Mines & Min—Sept., 1908. No. 94806 C.

Prospecting.

The Recognition of Minerals. C. G. Moor. A collection of notes and simple tests for the use of prospectors. 5500 w. Min Jour—Aug. 22, 1908. Serial. 1st part. No. 94774 A.

Shaft Sinking.

Shaft Sinking by the Freezing Process. An account of the sinking of two colliery shafts on the east coast of England to a depth of 484 feet through water-percolated soil and quicksand. Ills. 1500 w. Sci Am—Sept. 19, 1908. No. 95239.

Sinking a Reinforced Concrete Mine Shaft Near Wilkes-Barre, Pa. Louis L. Brown. The methods used for sinking this shaft of the D. L. & W. R. R. are illustrated and described. 2500 w. Eng News—Sept. 24, 1908. No. 95361.

Stoping.

Reclaiming Caved Ground After a Squeeze. J. J. Rutledge. Describes the method of mining at Davis, Mass. commenting on its disadvantages, and giving method of recovering the caved stope. Ills. 1200 w. Eng & Min Jour—Aug. 29, 1908. No. 94703.

ORE DRESSING AND CONCENTRATION.

Briquetting.

Iron-Ore Briquette-Making Plant. Illustrated description of a special plant for the manufacture of briquettes out of iron ore, as it has been found convenient for use in blast furnaces. 500 w. Engng—Sept. 4, 1908. No. 95053 A.

The Briquetting of Iron Ores (Das Brikettieren von Eisenerzen). An account of a discussion in the *Verein Deutscher Eisenhüttenleute*. 6300 w. Stahl u Eisen—Aug. 19, 1908. No. 95131 D.

Classifiers.

The Richards' Modern Pulsator Classifier and Jig. Illustrated detailed description. 3000 w. Min Wld—Sept. 19, 1908. No. 95209.

Concentration.

Methods of Concentration at Cobalt, Ontario. George E. Sancton. Brief description of methods at the Buffalo, the Cobalt Central, and Coniagas mines, and the proposed method at the Muggley concentrator. 3000 w. Can Min Jour—Sept. 15, 1908. No. 95247.

Filtration.

Filtration of Slimes at El Oro, Mexico. D. L. H. Forbes. Plan, sections and detailed description of plant for this purpose. 1100 w. Eng & Min Jour—Sept. 5, 1908. No. 94876.

Gold Milling.

Battery and Cyanide Gold Smelting. A. Thomas. An outline of present practice. 2500 w. Jour Chem, Met, & Min Soc of S Africa—July, 1908. No. 95038 E.

Apparatus for Extracting and Filtering Ore. J. E. Porter and A. L. Clark. Describes the cyaniding of dry crushed ore in new apparatus. Ills. 2500 w. Min Wld—Sept. 12, 1908. No. 95024.

The Goldfield Consolidated 600-Ton Mill. Percy E. Barbour. Illustrated description of plant and equipment. 5000 w. Eng & Min Jour—Sept. 5, 1908. No. 94879.

Milling Plant of the Montana-Tonopah Mining Company. G. H. Rotherham. Illustrates and describes a plant presenting new features for the treatment of gold and silver-bearing sulphide ores. 2500 w. Min & Sci Pr—Sept. 5, 1908. No. 94976.

See also Costs, under MINING.

Jigs.

See Classifiers, under ORE DRESSING AND CONCENTRATION.

Lead.

See Sorting, under ORE DRESSING AND CONCENTRATION.

Silver Milling.

Some Metallurgical Processes at Pachuca, Mex. Claude T. Rice. Cyanidation is rapidly replacing the older processes. Ills. 3000 w. Eng & Min Jour—Sept. 19, 108. No. 95243.

Slimes Treatment.

Slime Treatment in Western Australia. Percy Ifould. Principally devoted to a description of the Cassell process. 1800 w. Aust Min Stand—Aug. 12, 1908. No. 95369 B.

Sorting.

Ore Sorting at the Cabrestante Mine, Santa Barbara, Mexico. Claude T. Rice. Illustrates and describes methods of jigging and sorting lead-silver ores for shipment to the smelter. 1200 w. Eng & Min Jour—Sept. 5, 1908. No. 94878.

Stamp Mills.

Tremain Steam Stamps. Cyril E. Parsons. Describes these stamp mills and gives notes on the results obtained. Ills.

We supply copies of these articles. See page 326.

2500 w. Min & Sci Pr—Sept. 19, 1908. No. 95349.

MISCELLANY.

Alloys.

The Alloys of Iron (Les Alliages de Fer). A. Portevin. Summarizes the results of Prof. Tammann's researches on the alloys of iron with silver, gold, aluminum, bismuth, cobalt, cadmium, copper, manganese, nickel, lead, platinum, iron sulphide, silicon, tin, thallium, vanadium, vanadium-silicon and zinc. Ills. 7000 w. Rev de Métal—Aug., 1908. No. 95105 E + F.

Assaying Furnaces.

Assay Furnaces at the Melbourne University. Donald Clark. Illustrates and describes new and important improvements. 500 w. Aust Min Stand—July 22, 1908. No. 94816 B.

Ore Deposits.

Rock Pressure and Metamorphism. H. M. Chance. A study of earth stresses and their effects on rock structure. 3000 w. Min & Sci Pr—Aug. 29, 1908. No. 94854.

Association of Magnetite with Sulphides in Mineral Deposits. John B. Hastings. The present number quotes largely the opinions of experts in regard to such deposits. 2000 w. Min & Sci Pr—Sept. 5, 1908. Serial. 1st part. No. 94979.

See also Rand, under GOLD AND SILVER.

Petrography.

Identification of Rocks of Commercial Value. Evans W. Buskett. The occurrence and distinguishing features of rocks other than metallic ores, which have value. 2000 w. Min Wld—Sept. 12, 1908. No. 95023.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Collisions.

Collision at Contich, Belgium. Louis Weissenbruch. Also editorial. A report of the disastrous collision of passenger trains occurred last May and information relating to the operation of the Belgian State railways. 4000 w. R R Age Gaz—Sept. 11, 1908. No. 95002.

Derailments.

Concerning the Derailment of Tenders. F. P. Roesch. Discusses the causes and remedies. 2500 w. Ry & Loc Engng—Sept., 1908. No. 94825 C.

Signalling.

The First Interlocking Plant in America. J. A. Anderson. An account of an installation at Trenton, N. J, in 1870. Ills. 1300 w. R R Age Gaz—Sept. 25, 1908. No. 95353.

The Use of Special Semaphore Signals. L. Weissenbruch and J. Verdeyen. A discussion of the question of signalling shunting operations as practiced in Belgium and Germany. 3800 w. Bul Int Ry Cong—Aug., 1908. No. 94794 G.

The Signalling of the Glasgow Central Station, Caledonian Railway. Illustrated description of the interesting features. It possesses the largest locking frame in the world and the whole station is controlled from one signal-box. 3000 w. Engr, Lond—Sept. 11, 1908. No. 95292 A.

Signals.

New Forms of Distant and Home Signals in Germany. Hans A. Martins. Also note by Mr. Förderreuther. The signalling system in the Danish State Rys., and Bavarian State Rys. 3500 w. Bul Int Ry Cong—Aug., 1908. No. 94796 G.

Trains.

Asbury Park Flyer. Illustrated description of this fast train, and the country traversed. 1200 w. Ry & Loc Engng Sept., 1908. No. 94820 C.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Broken Air Pipes. Explains how the brakes can be operated from the engine when certain breaks occur. 1500 w. Ry & Loc Engng—Sept., 1908. No. 94824 C.

Brakes.

See Couplers, under MOTIVE POWER AND EQUIPMENT.

Cars.

Anti-Friction Side Bearings. A. Stucki. Discusses their forms and construction, etc. 1500 w. R R Age Gaz—Sept. 11, 1908. No. 95004.

Oliver 20-Yard Air Dump Car. Illustrated description. 500 w. R R Age Gaz—Sept. 4, 1908. No. 94886.

An Air-Operated Spreader Car for Railway and Other Work. Illustrated description. 800 w. Eng News—Sept. 17, 1908. No. 95222.

Our Ponderous Passenger Cars. Editorial on the weight of Pullman cars and means of reducing it. 1000 w. Sci Am—Sept. 26, 1908. No. 95334.

Steel Cars for Passenger Train Equipment. Illustrates and describes a number of steel cars for various railways. Also editorial discussing the design and construction of such cars. 11000 w. Eng News—Sept. 3, 1908. No. 94861.

Couplers.

Automatic Couplings and Hand Brakes for British Freight Cars. H. Raynar Wilson. Considers the reasons why they have not been adopted in Great Britain. 3000 w. Ry & Engng Rev—Sept. 19, 1908. No. 95241.

We supply copies of these articles. See page 326.

Electrification.

Midland Railway Electrification. An account of the first single-phase line in Great Britain. Ills. 6000 w. R R Age Gaz—Sept. 25, 1908. No. 95356.

Locomotive Design.

Correctives in Link Motion Design. Roger Atkinson. Describes modifications introduced which produce satisfactory results. 1000 w. Ry & Loc Engng—Sept., 1908. No. 94822 C.

Locomotive Fireboxes.

Sloping Fire Boxes on Locomotives. C. H. Caruthers. Reviews the history of fire boxes with a sloping roof-sheet and gives information relating to their use. Ills. 3000 w. R R Age Gaz—Sept. 4, 1908. No. 94882.

Locomotive Grates.

Locomotive Grate Area. Editorial on the Altoona tests. 1500 w. R R Age Gaz —Sept. 18, 1908. No. 95256.

Locomotive Repairs.

The Average Cost of Repairing Locomotives in America Compared with the Cost on the Northern Pacific, together with comments on plant depreciation and repairs. 1500 w. Engng Con—Sept. 2, 1908. No. 94857.

Locomotives.

Recent Locomotive Types Abroad. A R. Bell. Brief illustrated descriptions of recent types. 1000 w. Ry & Loc Engng —Sept., 1908. No. 94823 C.

The Passing of the Steam Locomotive. Wilson E. Symons. An illustrated review of the history and development, outlining improvements, with special reference to Chicago. Discussion. 9500 w. Jour W Soc of Engrs—Aug., 1908. No. 95390 D.

Heavy Tank Locomotives; British and Foreign. Charles S. Lake. Illustrates and describes examples of tank-engine design showing that larger and more powerful types are being employed. 3500 w. Mech Engr—Sept. 4, 1908. No. 95033 A.

Note on Some Recent Types of Express Locomotives. Maurice Demoulin. Discusses details of recent types and their performance. 3000 w. Engr, Lond—Aug. 28, 1908. No. 94953 A.

Express Locomotive, Southeastern and Chatham Railway. Illustrated detailed description of a modern locomotive exhibited at the Franco-British Exhibition. Plate. 250 w. Engr, Lond—Sept. 4, 1908. No. 95057 A.

Modern Locomotive Engineering in France. Charles S. Lake. Discusses the influence of the DeGlehn system, illustrating and describing types. 800 w. Prac Engr—Sept. 11, 1908. Serial. 1st part. No. 95275 A.

DeGlehn Compound Pacific Type Locomotive. Illustrated description of engines built in America, by the metric system measurements, for the Paris-Orleans Ry. 2500 w. Am Engr & R R Jour—Sept., 1908. No. 94826 C.

DeGlehn 4-Cylinder Compound Pacific Type Locomotives for the Paris-Orleans Railway. Illustrated detailed description of one of 30 locomotives built in America from drawings furnished by the railway company. 3000 w. R R Age Gaz—Sept. 11, 1908. No. 94999.

Tank Engine for the Rahway Valley. Illustrated description of an engine for passenger service on a short line. 600 w. Ry & Loc Engng—Sept., 1908. No. 94821 C.

Ten-Wheel Locomotives for the Southern Pacific. Illustrated detailed description of a recently built oil-burning engine. 900 w. R R Age Gaz—Sept. 18, 1908. No. 95259.

Mogul Locomotives for the Iowa Central Railway Co. Illustration, dimensions and description of one of six engines recently built. 800 w. Ry & Engng Rev—Sept. 5, 1908. No. 94895.

Superheated Steam Locomotives Designed and Built by the Berlin Maschinenbau-Aktiengesellschaft (Studien über Heissdampflokomotiven entworfen und ausgeführt von der Berliner Maschinenbau - Aktiengesellschaft vorm. L. Schwartzkopff). E. Brückmann. Illustrates and describes a number of recent locomotives. Serial. 1st part. 3500 w. Zeitschr d Ver Deutscher Ing—Aug. 15, 1908. No. 95180 D.

Two-Cylinder Compound Six-Wheeled Coupled Locomotive of the Luxey-Mont de Marsan Local Line and of the Bornand Marensin Railways (Note sur les Locomotives-Tenders à Six Rones Accouplées Compound á deux Cylindres du Chemin de Fer d'Intérêt Local de Luxey à Mont de Marsan et des Chemins de Fer du Born et du Marensin). M. Ménétrier. Ills. 4000 w. Rev Isen d Chemins de Fer —Aug., 1908. No. 95155 G.

Motor Cars.

Steam Motor Car for the Rock Island. Illustrated detailed description. 2000 w. R R Age Gaz—Sept. 18, 1908. No. 95263.

The Accumulator Car of the Mainz Railway (Die Akkumulatorenwagen der Eisenbahndirektion Mainz). K. Fürst. Illustrated detailed description. Serial. 1st part. 1200 w. Elektrotech Zeitschr—Jan. 30, 1908. No. 95306 D.

Refrigeration.

Pre-Cooling Plants in the South. Joseph H. Hart. Describes pre-cooling plants for the preparation of freight and vegetables for transportation and discusses their value. 2500 w. R R Age Gaz—Sept. 4, 1908. No. 94883.

Shops.

Early Locomotive Works. A review of early locomotive building in America. 2000 w. R R Age Gaz—Sept. 11, 1908. No. 95001.

We supply copies of these articles. See page 326.

Wheels.

Cast Iron Car Wheels. Editorial letter discussing the wheel question, the design, inspection, etc. 1600 w. R R Age Gaz—Sept. 18, 1908. No. 95258.

PERMANENT WAY AND BUILDINGS.

Curves.

See Track Maintenance, under PERMANENT WAY AND BUILDINGS.

Frogs.

Frog and Crossing Construction. Thomas P. Keane. Illustrated description of the Ramapo manganese hard-center bolted frog. 1200 w. Ry & Engng Rev—Sept. 5, 1908. No. 94896.

Rails.

Mechanical Defects in Rails. J. P. Snow. Discussion of Mr. Howard's paper, presented at the convention of the Am. Soc. for Test. Materials. 1400 w. R R Age Gaz—Sept. 11, 1908. No. 95003.

Rail Failures—Mashed and Split Heads. M. K. Wickhorst. From a paper before the Am. Soc. for Test Mat. Shows the relation of this type of failure to segregation. 600 w. R R Age Gaz—Sept. 4, 1908. No. 94884.

Steel Rails for Present Service; Their Manufacture and Their Failures. Dr. P. H. Dudley. An account of investigations made. Discussion. Ills. 5500 w. Jour W Soc of Engrs—Aug., 1908. No. 95388 D.

Stations.

High Tension Electrical Installations in Brussels Railway Stations (Les Installations à Haute Tension des Gares de l' Agglomération Bruxelloise). Emile Uytborck. Describes the uses to which electric power is put and the transforming and distributing installations. Ills. 6000 w. Soc Belge d'Elecns—Aug., 1908. No. 95102 E.

Switches.

Methods and Cost of Melting Snow in Switches. James S. Lang. From a paper before the Ry. Sig. Assn. 1200 w. Engng Con—Sept. 2, 1908. No. 94858.

Track Maintenance.

Track Maintenance at Curves. Dr. Heubach. The subject of methods of curve measurements is discussed, the maintenance of curves, rail wear, etc. 3500 w. Bul Int Ry Cong—Aug., 1908. No. 94795 G.

Readjustment of Curves and Tangents in Maintenance of Way Work. W. H. Wilms. Notes on the principles and methods involved in realinement of curves and tangents. Diagrams. 8500 w. Eng News—Sept. 17, 1908. No. 95223.

Yards.

Rock Island-Colorado & Southern Yards and Terminals at Galveston. Plan and illustrated description of recently constructed yards. 800 w. R R Age Gaz—Sept. 25, 1908. No. 95354.

TRAFFIC.

Commodity Clause.

The Coal Carriers' Decision. Editorial discussion of the recent decision of the U. S. Circuit Court of Appeals for the Eastern District of Pennsylvania. 1500 w. R R Age Gaz—Sept. 18, 1908. No. 95255.

"Commodity Clause," of I. C. C. Law Unconstitutional. Discussion of the clause that forbids railroad companies to transport in interstate commerce any article or commodity manufactured, mined or produced by them or under their authority, except lumber. 1700 w. R R Age Gaz—Sept. 18, 1908. No. 95261.

Freight Rates.

Texas Railroads' Reasons for Raising Rates. States facts in explanation of the railroad situation in Texas. 2000 w. R R Age Gaz—Sept. 4, 1908. No. 94887.

The Missouri River Jobbers' Case. Editorial discussion of the results of this decision of the Interstate Commerce Commission is enforced. 1500 w. R R Age Gaz—Sept. 18, 1908. No. 95257.

MISCELLANY.

Africa.

The West African Government Railways. Frederic Shelford. The Sierra Leone government railway and its equipment and operation is described. Ills. 2000 w. R R Age Gaz—Sept. 25, 1908. No. 95357.

Florida East Coast.

Importance of the Railway to Key West. William Mays Venable. Considers the wonderful engineering in the construction of the Florida East Coast Ry. extension to Key West, and its relation to traffic via the Panama Canal. Ills. 4000 w. Engineering Magazine—Oct., 1908. No. 95396 B.

STREET AND ELECTRIC RAILWAYS

Brakes.

The Freund Self-Winding Track Brake. Illustrated description of an ingenious mechanical track brake applied by a spiral spring. 1800 w. Elec Rev, Lond—Sept. 11, 1908. No. 95283 A.

Braking.

Taking Advantage of Transfer of Weight in Braking on One-Way Cars. W. H. McAloney. Shows the advantages that can be secured by such a transfer. 1600 w. Elec Ry Jour—Sept. 5, 1908. No. 94847.

We supply copies of these articles. See page 326.

The Felten & Guilleaume-Lahmeyerwerke System of Train Control (Die Zugsteuerung der Felten & Guilleaume-Lahmeyerwerke). Chr. Kraemer. Illustrates and describes the system. 3200 w. Elektrotech Zeitschr—Mar. 5, 1908. No. 95315 D.

Car Fenders.

Public Service Car Fender and Wheel Guard Tests. An account of tests to be held Oct. 20, 1908, at Pittsburg, Pa. 1200 w. Sci Am—Sept. 19, 1908. No. 95237.

Cars.

Philadelphia's Pay-Within Car. Cars remodelled for fare-prepayment are illustrated and described. 1200 w. Elec Ry Jour—Sept. 26, 1908. No. 95347.

Electric Traction.

Electric Traction on Tramways and Railroads. Gives method of calculating the traction effort, horse power, etc. 800 w. Mech Wld—Aug. 28, 1908. No. 94928 A.

Power Requirements in Trunk-Line Operation (Kraftbedarf für den Betrieb von Vollbahnen). R. Sanzin. Discusses the method of calculation, the points to be considered, etc. Ills. Serial. 1st part. 2500 w. Zeitschr d Oest Ing u Arch Ver—Aug. 21, 1908. No. 95163 D.

Elevated Railways.

The Problem of the Chicago Elevated Railway Loop. Editorial on the existing conditions, discussing means of improvement. 1800 w. Eng News—Sept. 24, 1908. No. 95364.

History.

The Development of the Electric Railway. James N. Hatch. An illustrated historical review, with discussion. 11000 w. Jour W Soc of Engrs—Aug., 1908. No. 95389 D.

Interurban.

The Ohio Valley Scenic Route. Illustrates and describes the lines of this route between Steubenville, Ohio, and East Liverpool, Ohio. 3500 w. Elec Ry Jour—Sept. 19, 1908. No. 95202.

The Kokomo, Marion & Western Traction Company. C. A. Tupper. An account of a very successful development of a railway, light and power distribution system. 3500 w. Elec Rev, N Y—Sept. 26, 1908. No. 95373.

The Traffic Problems of Interurban Electric Railroads. Thomas Conway, Jr. Discusses changed conditions and the early mistakes in construction of interurban lines, etc. 4000 w. Jour of Acc—Sept., 1908. Serial. 1st part. No. 95405 C.

Nottingham.

The Tramways of Nottingham. Illustrates and describes the successful municipal lines and their equipment. 4000 w. Tram & Ry Wld—Sept. 3, 1908. No. 95289 B.

Rail Corrugations.

The Formation of Rail Corrugations (Ueber Riffelbildung an Strassenbahnschienen). K. Sieber. A mathematical inquiry into the causes of their formation. Serial. 1st part. 4500 w. Elek Kraft u Bahnen—Aug. 14, 1908. No. 95169 D.

Railless.

General Urban and Interurban Transportation and Railless Electric Traction. F. Douglas Fox. Read before the British Association at Dublin. Aims to show in detail the comparative economics of the tramway and the mechanical omnibus. 4000 w. Elec Engr, Lond—Sept. 11, 1908. Serial. 1st part. No. 95280 A.

Single Phase.

Thamshavn to Lokken Electric Railway. A. C. Kelly. Illustrated description of the first single-phase line in Norway. 1500 w. Tram & Ry Wld—Sept. 3, 1908. No. 95288 B.

The Locarno-Pontebrolla-Bignasco Single-Phase Railway (Ferrovia a Corrente Monofase Locarno-Pontebrolla-Bignasco). S. Herzog. Illustrated description of this line, commonly called the Valle Maggia Line. Serial. 1st part. 1400 w. Industria—Aug. 23, 1908. No. 95122 D.

Equipment and Operation of the Electric City and Suburban Blankenese-Ohlsdorf Railway (Einrichtung und Betrieb der elektrischen Stadt- und Vorortbahn Blankenese-Ohlsdorf). C. Röthig. Ills. Serial. 1st part. 3000 w. Glasers Ann—Aug. 1, 1908. No. 95154 D.

The A. E. G. and Union E. G. System of Single-Phase Electric Traction on European Railways (La Traction électrique par Courant Alternatif Simple sur les Chemius de Fer en Europe, Système de l' Allgemeine Elektricitäts Gesellschaft et de l' Union E. G.). M. Henry. A general description. Ills. Serial. 1st part. 1600 w. L'Elecn—Aug. 1, 1908. No. 95109 D.

See also Electrification, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Subways.

Accounts of the London Electric Tube Railways. Gives tables of comparison, showing a complete analysis of the published accounts for the past half-year. 1500 w. Elec Rev, Lond—Sept. 11, 1908. No. 95284 A.

The Construction of the Paris Subway Lines. Louis Dubois. Gives particulars of interesting extensions being made and methods adopted. 2500 w. Elecn, Lond—Aug. 28, 1908. No. 94941 A.

Toronto, Canada.

Toronto's Pioneer Electric Railway. Brief account of what is said to be the first practical electric road in America. 1500 w. Can Elec News—Sept., 1908. No. 95078.

We supply copies of these articles. See page 326.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Camptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Architectural Composition.

Architectural Composition. By John Beverley Robinson. Size, 8½ by 6 in.; pp., 234. Ills. Price, $2.50. New York: D. Van Nostrand Company.

In any form of artistic composition too close adherence to theory and convention must inevitably result in defeating the true ends of art. Nothing more uninspiring could well be imagined than, for instance, an architecture based wholly on tradition and precedent. A work, therefore, which proposes in its preface to formulate the approved practice of architects in designing the exterior of buildings excites at first glance a not unnatural suspicion. One has only to read the first few pages of Mr. Robinson's book, however, to realize the value in architectural composition of the application of such theories as he puts forward. They comprise not hard and fast rules, but generalizations, developed in coherent and logical form, of principles which have long been recognized in their individual application. Such a treatment of the subject is one which cannot fail to give to architects themselves a truer conception of the æsthetic side of their profession and to form a profitable study for the structural engineer. The book is very profusely illustrated and attractively bound.

Harbor Engineering.

A Treatise on the Principles and Practice of Harbor Engineering. By Brysson Cunningham. Size, 9 by 6 in.; pp., 283. Ills. Price, $5. London: Charles Griffin and Company, Limited; Philadelphia: J. B. Lippincott Company.

The author's treatise on "Dock Engineering" has been long and favorably known; the present volume needs no further introduction than to say that it is intended as a companion treatise to the earlier work. The two subjects overlap at a good many points and it was impossible to produce a complete and self-contained treatise on the broader subject of harbor engineering without recapitulating a considerable amount of material which had already been used in the author's previous volume. The common material, however, is here presented from fresh points of view, with additional features of interest and new illustrations, and the book gains, rather than loses, in interest and value through its inclusion. In addition to a brief general introduction there are chapters on harbor design; marine and submarine surveying; piling; natural and artificial stone; breakwater design; breakwater construction; pierheads, quays and landing stages; entrance channels; and channel demarkation. The book is profusely illustrated and fully indexed.

Railroad Engineering.

The Elements of Railroad Engineering. By William G. Raymond. Volume II. Size, 9 by 6 in.; pp., xvi, 405. Ills. Price, $3.50, 15/. New York: John Wiley & Sons; London: Chapman and Hall, Limited.

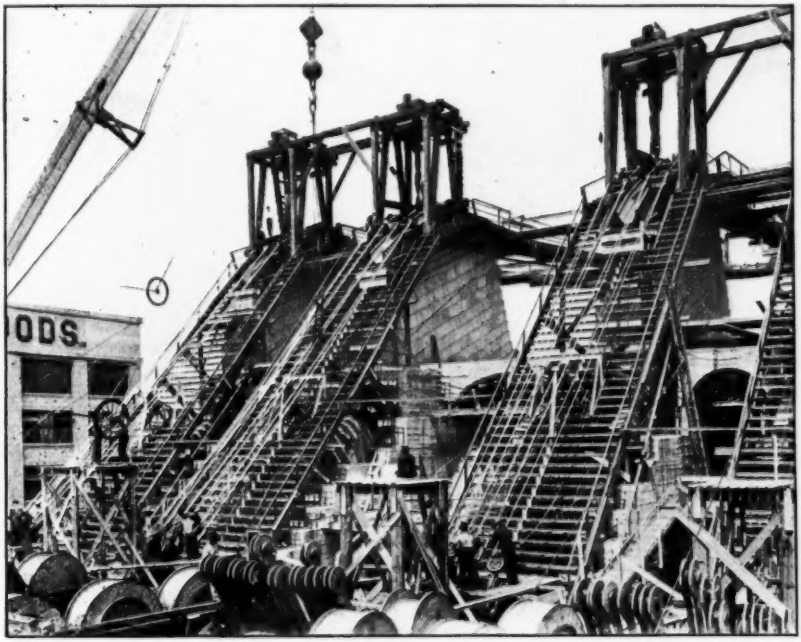
This book forms Volume II of a treatise on the whole subject of railroad engineering to be completed in three volumes. It deals with what may be termed Railway Economics. The first and third projected volumes will be entitled, respectively, Railroad Field Geometry and the Railroad Field-book.

The present volume consists of an Introduction, three main divisions, and an Appendix. The Introduction discusses in very condensed form the inception of railroad enterprises, company formation, stocks, bonds, engineers' estimates, construction, operation, over-capitalization, stock watering, railroad valuation, the relation between railroads and the public, and the duties of the engineer. Part I treats of the permanent way, separate chapters being devoted to alinement, rails fastenings, ballast, bridges, yards, signaling, etc. Part II discusses the locomotive and its work, with chapters on locomotive and grade problems, railroad expenditures, effect on operating expenses of change in the number of trains, problems of change of ruling grade, distance, rise and fall and curvature, and other subjects. Part III deals with railroad construction and betterment surveys. The appendix is a paper by W. D. Taylor before the American Society of Civil Engineers on the location of a new road, a branch of the Louisville and Nashville system across the Cumberland Mountains and the Clinch River Valley in Kentucky and Tennessee. The whole book is clearly conceived and admirably executed and should rapidly attain a foremost place as a text book and standard work of reference.

THE CURRENT RECORD OF
IMPROVED MACHINERY
NEW METHODS NEW MATERIALS
NEW APPLIANCES

Cable Hauling on the New Manhattan Bridge.

THE four huge cables that will support the new Manhattan bridge, connecting the boroughs of Brooklyn and Manhattan, are now being hauled into place. Each cable will contain thirty-seven strands of 256 wires each, a total of 9,472 wires in each cable, which must be strung wire by wire. The stringing of the wires in each cable is accomplished by means of two traveling sheaves carried on opposite legs of an endless steel rope. Each sheave consists of a three-foot grooved wheel fastened to the hauling rope by means of wrought iron brackets. The hauling rope is three-quarter inch in diameter and runs above the position of the bridge cables on heavy rollers supported on uprights on the temporary foot bridge. There are five of these hauling rope supports on the center span, two on each end span and one on each tower. The



hauling sheaves move back and forth across the bridge from anchorage to anchorage, a distance of 3,223 feet. They are attached one to each leg of the hauling rope so that they move in opposite directions, one crossing the bridge as the other returns.

The wire is delivered to the bridge on

enormous reels or spools, weighing three tons each. Half of these reels are placed at each end of the bridge. The end of the wire from a reel at each end of the bridge is put over the hauling sheave at that end and fastened to the anchorage. The machinery is then started and the sheaves move across the bridge, unwinding one wire from each reel. Two wires are thus strung by each sheave every time it crosses the bridge. When the sheave reaches the opposite side of the bridge the bight of the wire is taken off and made fast to that anchorage, and a new wire hauled from that side on the return trip.

The wires are laid in temporary saddles of four grooved pulleys at each anchorage. As the hauling of each strand of 56 wires is completed the wires are bound together at intervals, and the strand is lifted from the temporary saddle by means of a chain hoist and laid in its proper place in the permanent saddle. Two strands of each cable are wound simultaneously by the two sheaves of each hauling rope.

Each hauling rope is driven by a 50 h. p., 220 volt Crocker-Wheeler form W motor. This is the type of motor designed by the Crocker-Wheeler Company, Ampere, N. J., for rolling mill duty, and is well adapted to work of this kind where sudden overloads and frequent starting and stopping are likely. The motors are fully enclosed and capable of withstanding all kinds of weather and rough handling. Each motor is geared to a countershaft at a ratio of 5 to 1, and the countershaft is bevel geared to the driving shaft at a 5 to 1 ratio. On the driving shaft, above the gears is a wood lined, grooved, 6 foot traction wheel, which drives the hauling rope. A five foot idler wheel is also provided so that the hauling rope passes the traction wheel twice, to produce the necessary grip.

The hauling rope moves at a speed of approximately 480 feet per minute. It carries the sheaves across the river in about 7 or 8 minutes. Allowing for the time used in attaching wires at each end, about three trips are made per hour.

The driving motors are all located on the anchorage at the Brooklyn end of the bridge. The reels of wire are stored at both ends of the bridge. The work of building the cables is being carried on by the Glyndon Contracting Co., of No. 2 Rector Street, New York City.

The hauling equipment for this bridge differs from any previous attempt. In hauling the cables for the Williamsburg bridge two steam engines were used, connected to the same driving shaft. It later became necessary to cut this shaft and use the engines independently to avoid cumulation of delays. Even with that arrangement only two cables could be hauled simultaneously. The Glyndon Company's plant has double the capacity besides being electrically instead of steam driven, with the consequent ease of manipulation and control.

A New Motor-Driven Cable Reel.

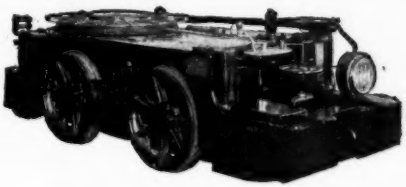
AT the Lackawanna colliery of the Temple Iron Company, Olyphant, Pa., there has recently been installed by the General Electric Company, Schenectady, N. Y., on one of the 6½ ton gathering locomotives a motor driven cable reel. This appliance exemplifies the latest development in gathering locomotives and is a distinct advance over the former methods of reel drive wherein the reel is driven by means of chain and sprocket from the locomotive axle or armature shaft.

In this new method the reel is driven by a small series wound vertical motor, the frame of which forms a support for the reel proper, which rotates in a horizontal plane on top of the locomotive. Double reduction gearing is used, the lower end of the armature shaft carrying a pinion which engages with a gear mounted on a vertical shaft provided with a special oilless bearing supported by a cast housing on the motor frame. The upper end of this intermediate shaft carries a pinion which engages in a solid plate gear on which the reel disc is bolted. Ball bearings are used throughout both for upper and lower armature shaft bearings and also for the reel, ball races being cut in the top of the motor frame and on the under side of the reel gear plate. The whole mechanism is

very simple and compact and consists of very few parts, none of which are subject to hard wear, and renewals are consequently very infrequent.

The motor is connected directly across the line with a resistance permanently in series in the circuit for preventing excessive flow of current. This circuit is controlled by a small single pole switch which may be opened when the locomotive is taking current from trolley pole and the reel is not in use. The capacity of the motor is such that it may be stalled on the line indefinitely without overheating.

The action of this series motor is analogous to a spiral spring of infinite



length and constant torque. With the locomotive standing still the motor will draw the cable taut and exert a steady tension on it. When the locomotive moves forward and slackens the cable, the motor instantly starts rotating and reels in the cable. Its tendency at all times is to produce a peripheral speed at the rim of the reel that is higher than the linear speed of the locomotive, so that there is a constant tension on the cable which insures its being wound compactly. When the locomotive changes direction and unreels the cable, the motor becomes a series generator and has sufficient counter-torque to produce a tension on the cable that insures its paying out evenly along the roadbed. The braking effect of this counter-torque is also sufficient to bring the reel to a stop the instant the locomotive stops.

This reel was installed some five months ago and has been in highly successful operation ever since. Its action is entirely automatic and the absence of all shifting levers and other auxiliary apparatus renders it very popular with the motormen. Beyond applying a little grease occasionally to the bearings, no other attention is required.

The fact that the reel drive is independent of any movement of the locomotive parts is a very important feature of its operation. When, as frequently happens with the locomotive running down heavy grades, the brakes are set hard enough to skid the wheels, there is no danger of running over the cable. With former methods of axle or armature shaft drive, any skidding of the wheels of course stops the reel rotation, resulting almost invariably in cutting the cable.

A rather interesting feature of the adaptability of the motor driven reel is illustrated by the manner in which it is now being operated by the Temple Iron Company. They have a section in their workings in which no trolley wire has as yet been strung, but a feed wire supplying power to another section of the mine runs along the roof. A point on this feed wire is bared and the cable hooked thereon. The locomotive then runs ahead and stops when the entire 600 feet of cable is unreeled. The cable is then unhooked and a short jumper wire connected to the feed wire at the point where the locomotive has stopped. The reel motor is then thrown in circuit, and when all the cable has been reeled in, it is again hooked to the feed wire at this point and the locomotive proceeds for another 600 feet, and so on indefinitely.

Lackawanna Steel Sheet Piling.

THE Lackawanna Steel Company has recently placed upon the market a new form of steel sheet piling. Each pile is a single piece complete in itself as it comes from the rolls, and requires no fabrication. The piling is a special rolled one-section bar, consisting of a web portion with flanges of like form at each edge thereof, adapted to engage with similar flanges of an adjacent section. The piling will interlock with the one previously driven.

The cuts represent more clearly the form of the piling as rolled, and it will be noted that in this piling the flanges on the same side of the web are similar

in design. The shorter flanges are hook shaped and engage with the corresponding hooked flanges of the adjacent section. The longer flanges are shaped as shown to form a guard around the hook of the previous section. When the piling is driven the hooked flanges prevent longitudinal displacement, while the guard flanges prevent lateral displacement, and assist to prevent longitudinal displace-

ment of the sections. The joint has three points of bearing which produce a positive and double interlock, firm and close, offering in a built up wall a rigid resistance to withstand the strain to which such a wall is subjected, particularly the longitudinal strain and the side or buckling strains. At the same time this interlock, with a bearing on both sides of the web, is such as to hold the piling in line while being driven, and to form a straight wall.

In the development of this bar by the Lackawanna Steel Company special attention was given to the design of the flanges which form the interlock to secure for this joint the maximum strength against pulling apart while being driven, and at the same time to produce a form which should be simple, interlock per-

fectly, and have the material so distributed as to give the largest radius of gyration, and correspondingly high strength.

The illustration shows the sections adopted, and before placing them on the market an experimental cofferdam was driven with 32-ft. lengths of 12¾ inch sheet piling. The material enclosed was subsequently excavated in order to ascertain the condition of the piling after driving, and to determine its efficiency as a protection against leakage. The result of this experiment proved that the interlock was perfect, and that the joints were practically water tight. A series of tests was also conducted to determine the strength of the interlock, and the average of these tests shows that with two 12¾ inch sections interlocked the joint has in tension a value of 9,700 pounds per linear inch of bar. It is therefore a desirable pile for work in which high tension stresses exist.

A feature of this bar is the ability to turn various angles and still maintain a perfect interlock, the shape of the interlocking flanges and hooks permitting a change of direction with a line of piling in case of the encountering of bowlders, etc. A piling of this character and form is specially adapted to the construction of retaining walls, foundations, cofferdams, submarine work, mine shafts, etc., where quicksand and water are encountered. An important feature of the Lackawanna piling is that when driven in ordinary soil, such as clay and quicksand, enough of the soil works into the joints to make them practically watertight. If driven in clear water the usual methods of packing, if necessary, may be employed to produce a water tight joint.

On account of its simple form it has many advantages in handling and driving. The friction area in the interlock, being three narrow surfaces, is at a minimum, so the piling can be easily driven and withdrawn a number of times, and when it has outlived its usefulness the discarded material can be sold for scrap.

An ordinary pile driver is used, the head of the piling being fitted with an iron cap having a wooden cushion interposed between the iron cap and the hammer of the pile driver. Satisfactory results have been obtained in keeping the vertical alignment of the bar. This is an important point, especially where a long wall is driven and long lengths are used. In the closing of rectangular pockets the vertical alignment must be true in order that the closing pile will drive freely for its full length and not strain the interlock.

Fabricated corners are formed by fitting the edges of two half sections at the desired angle by means of structural steel angles. Junction members for cross walls are made up of a full section, a

half section and two angles riveted together.

The 12¾ inch bar has been adopted for the construction of the cofferdam for the new government ship lock in Black Rock Harbor, Niagara River, at Buffalo, N. Y. This lock when complete will be one of the largest ship canal locks in the world. Before selecting the piling to be used in this harbor improvement a series of tests was made, subject to United States Government inspection, in which several makes of piling were driven, and the results obtained from the Lackawanna bar were so satisfactory that the contractors adopted it for this extensive construction. This is the largest single order of steel sheet piling ever placed for Government work, requiring 7,000 tons for the complete cofferdam. This cofferdam is 947 feet long, 245 feet wide outside dimensions at one end and 260 feet at the other end, and requires lengths of 44 ft. to 50 ft. of piling. The wall of the cofferdam is made of two lines of piling 30 ft. apart, with division walls at 30 ft. intervals, forming 30 ft. pockets. Later these pockets will be filled with clay to form the solid wall of the cofferdam.

Waterproofing Paint for Concrete.

THE rapid growth of cement and concrete construction in this country in recent years has caused architects and engineers to cast about for suitable waterproofing methods. The drawback to this type of construction is its porosity; no matter how great the care and attention given to the work voids must exist from the nature of the materials used. It is imperative, therefore, that structures reared by this method be waterproofed.

Lead and oil paints are entirely worthless for cement or concrete work. Cement contains an alkali having an affinity for oil, and it very quickly draws out the oil from the paint, leaving nothing save a dust shell behind.

The capillary attraction of concrete is well known, therefore cold water paints will not do the work nor will any material or materials added while mixing the ingredients prove satisfactory. Surface coatings will in time decay and lose adhesiveness and can then readily be pulled off in long strips. Those coatings depending on hardening for efficacy are waterproof so long as the protective coating formed by them does not check,

crack or suffer any abrasion, in fact, a cement grout plaster gives as good, or as poor, a result as this method.

The ideal method is to have the protective material penetrate the concrete and fill up the pores, not merely on the surface, as a skin, but for some distance into the mass.

Thomas A. Edison, in designing the reinforced concrete house for workmen, which he plans to pour in metal moulds, made the roof of concrete, and desiring to waterproof it, tested out most of the waterproof preparations now on the market, but did not find anything which was entirely satisfactory both in results and costs, so with his chemists he started a series of experiments which resulted in the production of a perfect waterproof paint which will be known as Anhydrol.

Anhydrol is an entirely new departure. The mineral base is not ground in its manufacture, but is made soluble at a high temperature by certain volatile liquids, and when applied penetrates the material to the depth of from ⅛ in. to ½ in. and fills every pore and void. The volatile carriers, having done their work, evaporate, leaving the base thoroughly identified with the mass of the structure to a depth of approximately one-half inch. This material never hardens, remaining always soft and pliant. It is not affected by sea or rain water, acids or alkalies, heat or cold. Being a part of the structure it can never flake or crack off. Being antipathetic to water, capillary attraction has no terrors for it. It can never be removed nor its efficiency lessened save by the destruction of the structure.

Anhydrol contains no grease, paraffine, tar, glue, lead, casein or water. It is absolutely impervious to water. Cement, concrete or brick treated with it defies the entrance of water. Cement briquettes and bricks treated with it can remain under water for months with no increase in weight: a severe test for a waterproof compound. Anhydrol will waterproof and dampproof any concrete or cement construction, mass or block; brick work; cement and mortar joints; any porous stonework; clay or cement tile, concrete or concrete slab roofs; concrete and cement floors and walls; cellars, etc.

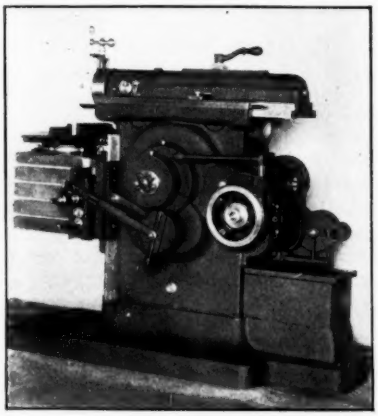
Insoluble in water it does not discolor it or cause it to taste and therefore can be used with perfect safety on the inside of reservoirs, tanks, etc. It can be painted over with any desired color without danger of discoloration. It prevents egress of soluble salts and therefore where it is used there can be no disfiguring efflorescence. Overcoming capillary attraction it shuts out all moisture and consequent frost action.

No expert is needed to apply it as it is put on with a brush like any paint. The surface to be waterproofed must be dry and carefully brushed with a stiff brush or broom; the first coat should be carefully brushed in; the second coat should be applied after the first has dried. Care should be exercised not to use more than the surface will absorb. A gallon will cover, two-coat work, from 90 to 135 square feet, varying with the porosity of the material.

Further particulars may be had by addressing the North Jersey Paint Co., St. James Bldg., New York.

All Gear Drive Shaper.

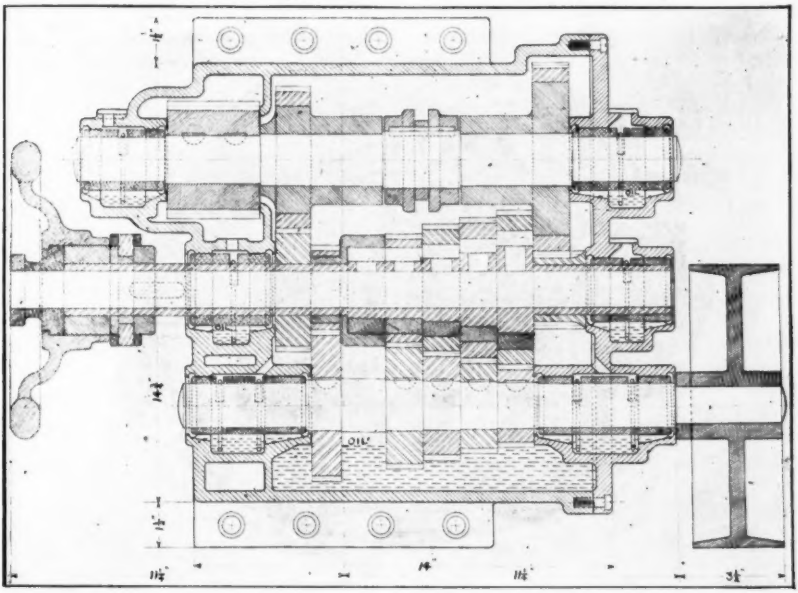
THE illustrations furnish an example of a machine every piece of which was built to do its work in this particular machine. It is not a regular shaper,



with a gear box as an after-thought—the whole machine was designed and built for an all geared drive shaper. This shaper embodies all the special fea-

tures common to all shapers, and several new features that will add quite materially to its productiveness.

The requirements of a gear box are simplicity in its construction and operation. The aim in this gear box has been to meet these requirements. From the sectional drawing of the gear box will be seen that in all ten changes of speed for each position of ram can be had—five with the direct drive and five with back gears. The horizontal handle shown on the cut of the machine operates a plunger which in turn raises a wedge pin which expands the friction ring on which the driving gear is carried. The gear necessary to give the required speed to the ram is found from the dial located in the center of the hand wheel on the working side of machine. This dial is marked with numbers giving strokes of the ram per minute for each gear. A single turning of this dial brings the gear desired in position to be engaged, when the plunger is operated, without engaging any intermediate gears. Any adjustment of the friction ring that may be necessary, owing to slight wear, is provided for by means of a screw which can be adjusted through the hand hole in the back of the gear box. The hand wheel is of use in moving the ram by hand in case it is desired to do so. The gears run in oil and the boxes are all bronze bushed and provided with self-oiling bearings. The gear box being at the back of the shaper and bolted direct to the column makes not only a stronger, stiffer drive compared with a gear box built out from the side of shaper, but its compactness is quite an advantage where floor space counts.



The Stockbridge two-piece-crank is used on this machine, giving an even cutting speed the entire length of the cut, together with a very quick return of between 3 and 4 to 1. There is also a gain in power by the use of this crank, which makes necessary special design in the connecting parts, special attention having been given to the construction of the rocker arm, as it is through this piece that the motion of the crank is communicated to the ram.

The rocker arm is made with a cored U shaped rib on either side, giving as rigid a construction as could possibly be made. The slot in the rocker arm is made of unusual depth and width to provide ample bearing surface for the crank pin

block. The rocker arm is held between two boxes at the bottom and tied to the ram at the top, preventing the possibility of any tendency to twist.

The ram is of new design. The object of carrying the top down part way on a small circle with the straight sides the rest of the way is to gain in stiffness and prevents possibility of buckling. The ram is well braced and ribbed on the inside.

The machine is provided with both automatic down and cross feeds, and with micrometer collar graduated to read to one-thousandth of an inch. Taper packings adjusted by means of screws at either end are used throughout.

The adjusting gib is on the working side of machine, and by simply tightening the two binder screws, the bar is locked to the column as if it were part of it. In this way the time necessary for the operator to go around on the opposite side of the machine to loosen and then to tighten binder bolts, where two loose gibs are used, is done away with.

In addition to the large bearing surface on its face the driving gear has its hub supported both on the outside and inside, thus doing away with all possibility of buckling, when shaper is on a long stroke. The machine is equipped with either revolving table or regular box table. The vise is of swivel type, having a graduated base reading to degrees. The base is extended well out in front and has cored T slots for bolting work to base. For motor drive the base is extended at the back and built up to receive the motor. Any constant-speed motor can be applied: a speed of about 1,200 r.p.m. is recommended, however. In the case of a single pulley drive the regular base (without the extension for the motor) is used and the pulley is put on in place of gears connecting the motor.

The Stockbridge Machine Co., Worcester, Mass., will be glad to furnish further particulars regarding this shaper.

Face Grinding Machine.

THIS machine is designed for grinding lathe and planer tools, for edge grinding and squaring up ends of work, and for the general miscellaneous small jobs of grinding in the tool room and in the shop.

One of the novel features of this machine is the provision for use of a diamond for truing up both the face and the periphery of the wheel.

A straight edge or surface on tools and a straight face on the edges of work, is

much easier and more accurately obtained by using the face of the wheel, provided that face be straight and the wheel be of suitable character. Such a face cannot be obtained with an emery wheel dresser nor can the diameter of the wheel be kept true with a dresser.

Recognizing these facts the manufacturers of this tool have provided a work table located in front of and extending by the edge of the wheel, so that both the face and edge of the wheel can be used for grinding. This table is located

in a guide carried by a transversely swinging arm, and in the end of the arm a longitudinally adjustable diamond holder is located; normally the table can be either clamped, to prevent any transverse rocking movement, or adjusted to allow a certain amount of such movement, as is often an advantage in grinding wide work. When the surface of a wheel becomes dull or untrue an adjustable stop below the table is moved out of its path and the table swung backward away from the wheel, at the same time swinging the diamond across the face of the wheel so as to give the latter a good cutting and a straight surface.

The table is also slidable longitudinally of the machine in the guide and is provided with a threaded hole to receive the diamond holder, which may be transferred to this hole and the edge of the wheel trued off, by sliding the table in its guide. The table guide is pivoted in the diamond carrying arm and can be set by means of graduations and clamped at any angle with the face of the wheel up to 45 degrees.

Upon the table is also provided an adjustable squaring device or protractor which may be set from 90 degrees to 45 degrees with the surface of the wheel.

The diamond holder may be quickly transferred from one end of the machine to the other and with a little care the diamond will last indefinitely.

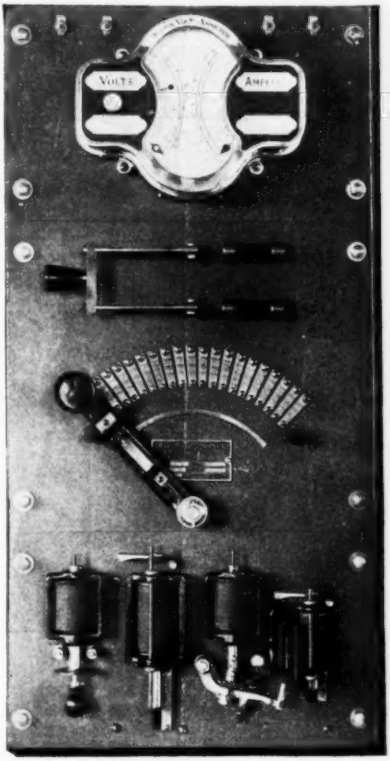
The wheel spindle of this machine is hardened and runs in adjustable bronze boxes. The wheels used are 12 inches in diameter by 1½ inch thickness and are recessed. A water tank of ample capacity is provided for cooling work, located convenient to the operator.

This machine is manufactured by the Emmert Mfg. Co., Waynesboro, Penna.

Battery Charging Rheostat.

THE demand for a battery charging rheostat which will not only meet all requirements of battery charging service, but which shall possess automatic protective features as well has led The Cutler-Hammer Mfg. Co., Milwaukee, to place on the market the panel here illustrated.

This battery charging rheostat consists of a slate front mounted on an angle iron frame containing the resistance, the whole being designed for attachment to a wall or switchboard. The panel, which carries all of the operating mechanism consists of three separate pieces of slate. On the face of the uppermost slate are mounted the terminals, or binding posts, and a Weston-volt-



1 2 3 4

ammeter. The middle slate carries a double pole knife switch and fuses (National Electrical Code Standard) and below these the contact segments and operating lever, by means of which the charging current is regulated. On the slate at the bottom of the panel are mounted the automatic, protective devices, which are:

(1) A low current cut-out which au-

tomatically opens the circuit if the current drops to a predetermined minimum. This prevents the battery from discharging into the line should the line voltage drop below that of the battery.

(2) A maximum voltage cut-out. This automatically opens the circuit when the battery voltage reaches the point at which the cut-out is set to operate.

(3) A solenoid switch the opening or closing of which "breaks" or "makes" the main line charging circuit.

(4) An overload circuit breaker which automatically opens the circuit if the charging current rises to the point at which the breaker is set to operate. This insures the battery against being charged at an excessive rate.

The operation of this type of battery charging rheostat is as follows: After the battery and line connections have been made the operator first closes the knife switch and then moves the operating lever forward to the third contact segment, at the same time raising the plunger on the low current cut-out (1), thus energizing the solenoid switch (3) which closes and permits the charging current to flow to the battery through the resistance.

If at the beginning of the charge the operating lever is not in the starting position (that is to say, resting against the rubber stop-post at the left) it must first be brought to the starting position and then moved to the third contact segment as described above. It may then be moved further and further to the right, cutting out one step of resistance after another and increasing the amount of current until the desired amperage (as indicated by the ammeter) is obtained.

Should the current fail, or reverse, the low current cut-out (1) will release its plunger, thus deenergizing the solenoid switch (3) which will in turn open the main circuit. Should the charging current reach the point at which the overload circuit breaker (4) is set to operate this will open the main circuit. Finally, when the charge is continued until the battery reaches the voltage at which the maximum voltage cut-out (2) is set to operate. This will automatically open the circuit, thus insuring the battery against an overcharge.

It will be evident from the description that the use of this panel protects the battery under all charging conditions as it not only guards against an excessing charging current, but also prevents the battery discharging back into the line should the line voltage fall below the voltage of the battery. It possesses, moreover, the advantage of requiring no attention after the charge is once begun, since the maximum voltage cut-out (2) will cut off the current automatically when the battery is fully charged.

As an additional protection the operating lever is provided with an electrical interlock which prevents the operator from closing the circuit to the battery except when the lever is in the "off" position, that is to say, with all resistance in circuit.

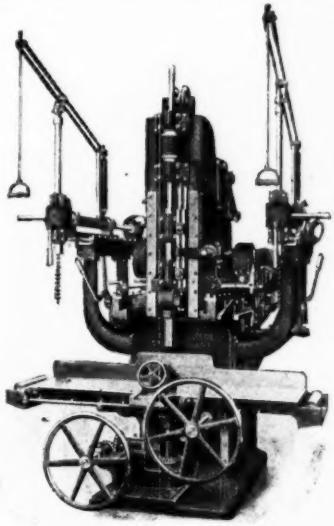
These battery charging rheostats are made at the New York works of The Cutler-Hammer Mfg. Co., 130th St. and Park Ave., New York.

Car Mortiser for Heavy Work.

THE accompanying illustration represents the latest car mortiser built by the J. A. Fay & Egan Company, of 212-232 W. Front street, Cincinnati, Ohio. It is designed for heavy work in both car and bridge construction, and is made with one, two or no auxiliary boring attachments. It has a capacity for mortises from ½ in. to 3 ins. square, and up to 6 ins. deep; or, by reversing timbers, 12 ins. deep. The frame is a single-cored casting with wide base. The housing is secured gibbed to the frame with provision for taking up wear and moves transversely on frictionless rollers by hand wheel, and can be securely locked in any position desired. The chisel ram is gibbed to the housing, and has a vertical travel of 18 ins. The auger spindle is driven at the proper speed by a belt with take-up so that the strain is constant regardless of the position of the housing. The reciprocating motion of the chisel ram is produced by a pinion in a rack operated by friction pulleys, giving a constant and positive drive. The table is made either stationary or

traveling. The stationary table is 6 ft. 6½ ins. long and is provided with stops to regulate the length of mortise. It is operated by hand wheel, rack and pinion and can be raised and lowered by hand. The traveling table can be furnished any length desired. It is made of steel I beams, has automatic feed under instant control of the operator, and is provided with adjustable stops for regulating the distance between mortises. The countershaft is self-contained in the base of the machine, convenient for direct motor drive.

The auxiliary boring attachments angle 30 degrees in either direction. The



two spindles have a vertical stroke of 18 ins. and a lateral adjustment of 18 ins., and are driven by independent countershafts, having tight and loose pulleys. For further information write the manufacturers, who will be pleased to send you descriptive circular by return mail.

Tools for Use with Renold Silent and Roller Chain.

THE introduction of Renold chains to American trade was an epoch-making circumstance, which has been of appreciable importance to the manufacturers of all classes of machinery in which the method of power-transmission figures largely. As the chains are familiar generally, this mention refers principally to two novel accessories for assembling, though a brief outline of the improvement in the joint of the chain is

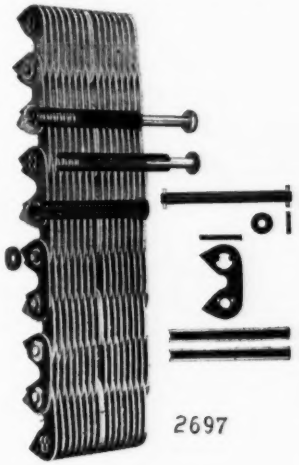


FIG. 1.

included. As shown by Fig. 1, two semi-circular bushings are used in each joint, both being of a length equal to the width of the chain. This new arrangement besides allowing for the proper ar-

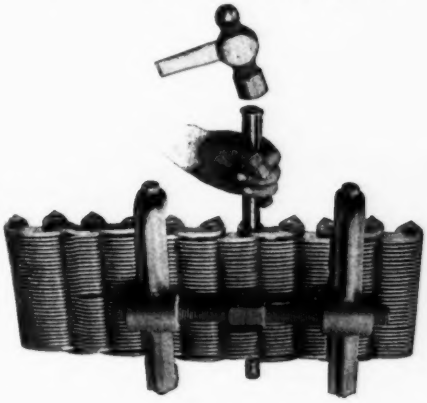


FIG. 2.

ticulating movement, permits complete rotation of the pin, which is of decided value, inasmuch as possible wear is thus rendered free from unevenness, while the accuracy of fit minimizes any ten-

dency to elongation with its accompanying wobble. Another point made in favor of the new construction is the complete absence of contact between links and

termed a cramp—a specially designed holder made of cast-iron members for gripping the ends of the chain, and connected by a screw for drawing the

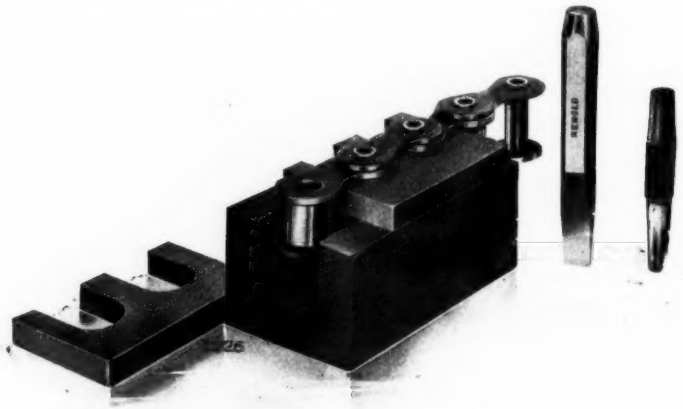


FIG. 3.

pin, which relieves the latter of concentrated pressure and eliminates the internal wear so destructive to proper service.

In the process of installing the chain drives, the makers devised special appliances to facilitate the work of connecting the links. Fig. 2, shows what is

gripped ends together when fastening them. This is accomplished by fitting the bushings to a short drift pin of proper diameter to lead into the holes of the links, after which the pin is inserted and with a few light blows is driven into position.

The device shown by Fig. 3, termed a "fork and anvil," is used exclusively with the roller type of chains. With it these may be handled very easily, as it is only necessary to slip the forked part between the rollers, with the lower part of the links hanging into the channel of the anvil block. Release of the links may be made quickly by slipping the fork off the anvil. The advantage of these tools in being of a size that is easily portable will command them to users who have occasion to lengthen or shorten drives, or otherwise make changes in the chains. A punch and chisel are included in a kit. These tools are made and

sold in America exclusively by The Link-Belt Co., Philadelphia, Chicago, Indianapolis.

O. K. Tool Post.

THE O. K. tool post illustrated herewith holds the tool on the side, thus enabling the operator to get up near to the chuck or face plate. With this tool post the tool is adjusted vertically, thus keeping the clearance on cutting tool always the same.

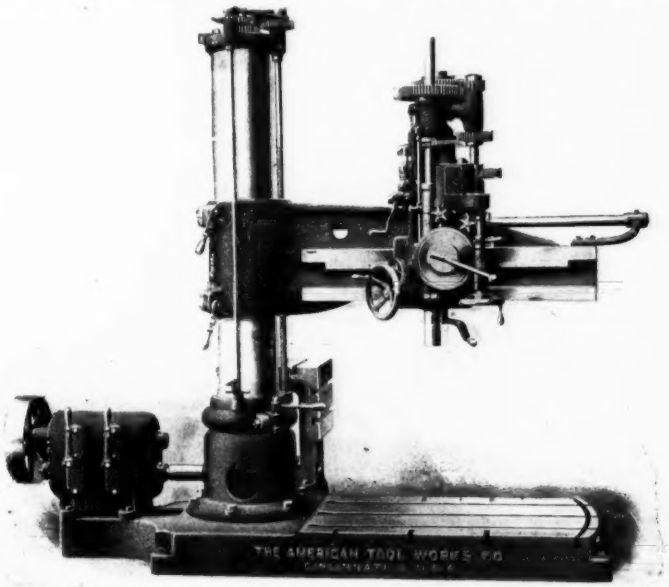
The tool post swings around at any angle. After once placing in the desired position, the process of tightening has no tendency to twist the tool post. The bolt is made to fit the T slot so that there is no danger of injuring same. The nut is made to fit the tail stock wrench. When it is necessary to grind the tool and it is desired to remove the tool or holder, the vertical adjustment is not affected. By swinging the tool post around at right angles and using a small V block, it makes the strongest kind of a boring tool holder. All parts are steel drop forgings, carefully machined all over, case-hardened and interchangeable.

The makers are the O. K. Tool Holder Co., Shelton, Pa.

High Speed Radial Drill.

THE American Tool Works Co., Cincinnati, have placed on the market a triple geared high speed radial drill.

The advent of high speed steel twist drills, particularly those designed after the Celfor pattern, has opened up a new field for extremely rapid drilling. This style of drill affords such liberal clearance as to overcome the crowding tendency of chips at high speeds and heavy feeds, which absolutely prevent the ordinary twist drill from being operated to the limit possible with this new drill.



The machine is endowed with a wide range of spindle speeds, and the ability of the tool to transmit an abnormal amount of power for this class of drilling machine, makes it particularly adapted to the most severe tapping requirements.

Particular attention is called to the power of the frictions in the speed box, tapping attachment and feed worm

wheel, the latter operated by quick return handle.

By rounding the edges of the teeth of the gears in the triple gear mechanism the gears may be thrown in at high speed with practically no shock to the parts, thereby making the machine foolproof and facilitating very rapid manipulation without danger of breakage. This "no shock" feature, and the fact that all other speeds are thrown in by frictions, demonstrates the possibilities of rapid handling with absolutely no danger to the machine, which is not possible where it is necessary to engage slip gear and jaw clutches of the ordinary type.

Personals.

—Wilhelm J. D. Keuffel, president of the Keuffel & Esser Co., manufacturers of surveyors' instruments, died recently of apoplexy at his home in Hoboken.

—Frederick H. Leland, E. E. M. E., announces that he has become associated with Marwick, Mitchell & Co., chartered accountants, as an industrial specialist at their American offices, 79 Wall Street, New York.

—At the last meeting of the Missouri Manufacturers' Association, J. A. J. Shultz, president of the Shultz Belting Company, was elected president of the Association. This is a Missouri State Association with headquarters in St. Louis.

—Harry Pennington, Lumberman's National Bank Building, Houston, Texas, announces that he has been appointed Texas agent for the Wheeler Condenser & Engineering Co., of Carteret, N. J.

—C. R. Robinson, formerly sales agent for the Inland Steel Co., Chicago, resigned October 3rd to accept the position of Chicago representative for the Lackawanna Steel Co., with offices in the Commercial National Bank Building.

—Arch. S. B. Little, formerly general manager of the New Conveyor Co., Ltd., England, and recently in charge of the gas department of the Missouri Fire Brick Co., has been engaged as chief of the gas works division started by the Evens & Howard Fire Brick Co., St. Louis.

Industrial Notes.

—Standard Gauge Mfg. Co., announces the removal of their offices and works from Syracuse to Foxboro, Mass.

—American Blower Co., Detroit, reports the receipt of a very satisfactory volume of business, which seems to be keeping up very well.

—The Bucyrus Co., So. Milwaukee, have opened a New York office at Hudson Terminal-Fulton Building, 50 Church Street. George B. Massey, 2nd, will be in charge.

—The Rail Joint Co., New York, has established a branch sales office in the Call Building, San Francisco. James A. Greer, of the sales department in New York City, will represent the company.

—Turner Construction Co., 11 Broadway, New York, have been awarded a contract by the Long Island Railroad Co. for the construction of 1,800 feet of reinforced concrete fence in connection with their Atlantic Ave. freight yards.

—The Engineering Service Co., Inc., 90 West St., New York, announce that they have established offices for the transaction of a general electrical engineering and contracting business, in the equipment of industrial, power and other plants. Gerard B. Werner, E. E., is president and Robert Josephi, E. E., secretary and treasurer.

—L. B. Marks and J. E. Woodwell have opened offices as consulting engineers in the Terminal Building, 41st St. and Park Ave., New York. They will cover not only illuminating engineering, but all related work incident to the generation, distribution and application of electric current for light, heat and power.

—J. G. White & Co., Inc., 43-49 Exchange Place, New York, have begun the surveys for F. H. Buhl, of Sharon, Pa., on one of the largest irrigation projects ever undertaken, contemplating the reclamation of about 700,000 acres of arid land in Southern Idaho. The project is practically an extension of the noted Twin Falls development.

—Whiting Foundry Equipment Co., Harvey, Ill., have just furnished the Standard Cast Iron Pipe & Foundry Co., Bristol, Pa., with two No. 12 cupolas, which are notable for their size, having a capacity of 30 to 35 tons per hour. Shell is 108" in

diameter, and wind box 130", with a 10½" lining. It is fitted with two rows of tuyeres, eight in each row.

—The Sprague Electric Company has found it necessary in order to handle the increasing demand for its products, in the Southern territory, to open a branch office in Atlanta, Ga., in addition to the New Orleans office. Both of these offices are under the management of F. V. L. Smith, who has been in charge of the Sprague Company's office in New Orleans since its establishment. The Atlanta office is located in the Empire Building.

—The rapid increase in the number of electrically operated railway systems in Japan is gratifying to American manufacturers of electric railway apparatus, and the orders resulting therefrom bid fair to equal those created by the demand for power apparatus for industrial purposes. Among the orders recently listed by the General Electric Co., Schenectady, is one of the Kobe Electric Railway Co. of Kobe, Japan, a seaport town of some 200,000 inhabitants.

—C. L. de Muralt has been reappointed Professor of Electrical Engineering at the University of Michigan for the coming year. During the winter semester Prof. Muralt will devote his attention to the consideration of the more general aspects of applied electricity. The course of lectures will include the discussion of (1) the characteristics and application of alternating and continuous current motors, (2) the design, construction and operation of electric plants, (3) the principles and methods of transmitting, distributing and controlling alternating currents, (4) the calculation and operation of electric railways and (5) the management of electric properties, with special references to the commercial aspects of electrical engineering.

—The *General Electric Review* for October contains the following articles: An Outline of the Transformer Department of the General Electric Company, at Pittsfield, Mass., by W. A. Hall; Wireless Telegraphy, by Prof. Elihu Thomson; Transformer Steel, by W. S. Moody; Electric Theory of Matter, by Prof. Harry C. Jones; Large Shell Type Transformers, by E. R. Pearson; A Well Lighted Office, by B. G. Worth, Jr.; Three-Position Automatic Signals on the Baltimore & Ohio Railroad, by F. B. Corey; Electricity in Gas Plants, by J. S. Knowlson; The Electrical Equipment of the Anheuser-Busch Brewery, by Wm. Hand; Electric Power vs. Steam Power, by R. E. Barker; Radial Reflectors for Series Tungsten Lamps, by T. K. P. Stilwell; Natural Gas and Electricity, by J. F. Schaefer; Multiple Operation of Transformers, by W. J. Wooldridge, and Regulate Stocks Now, by J. E. Perego.

NEW CATALOGUES AND TRADE PUBLICATIONS

NOTE.—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index. See page 11.*

Air Compressors.

INGERSOLL-RAND CO., 11 Broadway, New York—Catalogue illustrating and describing small power driven air and gas compressors. 6 by 9 in.; pp. 50. Also booklets treating of electric-air rock drills and channelers; rock excavating machinery; and pneumatic pumping systems.

Bearings.

HILL CLUTCH CO., Cleveland—Catalogue illustrating and describing, together with dimensions, collar oiling bearings. 4½ by 8 in.; pp. 40.

Drills and Chucks.

CELFOR TOOL CO., 207 Railway Exchange Bldg., Chicago—Bulletin illustrating and describing twist drills and chucks. 5 by 7 in.; pp. 22. Also a bulletin treating of flat drills and chucks. Illustrated. 5 by 7 in.; pp. 16.

Electrical Equipment.

WESTERN ELECTRIC CO., Chicago—Two bulletins describing electrical equipment for hotels and department stores. Illustrated with views showing some recent installations.

GENERAL ELECTRIC CO., Schenectady, N. Y.—Bulletins Nos. 4616, 4617, 4618 and 4622 illustrate and describe high-voltage transformers; direct connected generating sets; belt-driven alternators; and polyphase maximum watt demand indicators respectively.

Engineering Instruments.

ISZARD-WARREN CO., 1122 Vine St., Philadelphia—Catalogue illustrating and describing, together with prices and sizes, transits and levels, engineering field equipments, drafting room outfits and supplies. 6 by 9 in.; pp. 228.

Feed-Water Purifier.

HOPPES MFG. CO., Springfield, O.—Catalogue illustrating and describing live steam feed-water purifiers and exhaust steam feed-water heaters.

Steam separators, oil eliminators; and exhaust heads are also treated. 9 by 6 in.; pp. 40.

Filing Cabinets.

D. J. Burlingame, First National Bank Bldg., Chicago—Catalogue devoted to an illustrated description of vertical cabinets for the filing of drawings, tracings, blue prints, maps, sketches, artists proofs and large prints which should not be folded. Also gives sizes, prices, etc. 6 by 9 in.; pp. 8.

Gas Engines.

Buckeye Engine Co., Salem, O.—Catalogue illustrating and describing four-stroke cycle gas engines. Also contains table giving the amount of fuel consumed by producer gas power plants with various bituminous coals and lignites. 9 by 6 in.; pp. 44.

Grab Buckets.

Andresen-Evans Co., Monadnock Block, Chicago—Bulletin No. 1 is devoted to an illustrated description of grab buckets for ore and coaling handling plants. 11¾ by 8¾ in.; pp. 16.

Graphite Bushings.

Graphite Lubricating Co., Bound Brook, N. J.—Catalogue briefly describing graphite and bronze bushings, bearings and washers, together with numerous testimonial letters from users. Illustrated. 9¾ by 5¾ in.; pp. 32.

Heating and Ventilating Apparatus.

Bayley Mfg. Co., 732 Greenbush St., Milwaukee—Catalogue No. 26 illustrates and describes heating, ventilating and drying apparatus. 6 by 9 in.; pp. 114. Also catalogues treating of generating sets and vertical engines. 6 by 9 in.; pp. 20.

Industrial Locomotives.

Jeffrey Mfg. Co., Columbus—Bulletin No. 13 illustrates and describes electric locomotives for industrial haulage. The bulletin is well printed and contains many views showing some actual installations. 8 by 10 in.; pp. 32. Bulletin No. 22 contains an illustrated description of coal tipples and shaking grates. 6 by 9 in.; pp. 48.

Lamps.

Nernst Lamp Co., Pittsburg—Bulletin B illustrates and describes, together with prices, Westinghouse Nernst multiple-glower lamps. 4½ by 6 in.; pp. 40.

Lift Bridges.

Scherzer Rolling Lift Bridge Co., Monadnock Block, Chicago—Well-printed, cloth bound, catalogue describing, by means of illustration and text, the many advantages of the rolling lift bridge over the old type of center pier swing bridges. Also contains many views showing lift bridges erected by them in both open and closed positions, together with numerous testimonial letters. 10½ by 7 in.; pp. 140.

Molding Machines.

Arcade Mfg. Co., Freeport, Ill.—Illustrated catalogue descriptive of molding machines designed to handle light castings, such as are usually made in flasks 14 by 22 inches or less. 6 by 9 in.; pp. 24.

Motors.

Fort Wayne Electric Works, Fort Wayne, Ind.—Bulletin No. 1111 illustrates and describes electric motor drives as applied to machine tools. 8 by 11 in.; pp. 24.

Northern Electrical Mfg. Co., Madison, Wis.—Bulletin No. 59 is devoted to an illustrated description of type S motors for mill and factory service. 8 by 10½ in.; pp. 12.

Plating and Polishing Machinery.

Zucker & Levett & Loeb Co., 516 W. 25th St., New York—Illustrated catalogue descriptive of nickel and electroplaters' supplies, polishing materials and dynamos for electro-plating, electrotyping and all purposes requiring low voltage. Fully indexed. 6 by 9 in.; pp. 222.

Power Transmission Machinery.

Barnard & Leas Mfg. Co., Moline, Ill.—Catalogue P illustrates and describes sprocket wheels, link belting, rope transmission appliances, pulleys, hangers and bearings of all kinds, etc., together with prices. 6 by 9 in.; pp. 84. Also a loose-leaf catalogue descriptive of flour mill and elevator machinery.

Pumping Machinery.

American Steam Pump Co., Battle Creek, Mich.—Booklet containing a brief illustrated description of vacuum pumps. Also contains several tables giving details and sizes. 3½ by 6 in.; pp. 16.

Lea Equipment Co., 136 Liberty St., New York—Bulletin G contains a general description of high-duty turbine pumps. Also gives the result of Prof. James E. Denton's test of the capacity and efficiency of the Lea-Degen two-stage centrifugal pump. Illustrated. 6 by 9 in.; pp. 16.

Skylights.

Thomas W. Irwin Mfg. Co., Itasco and Rebecca Sts., Pittsburg—Catalogue containing a brief description of skylights and illustrations of some recent installations. 8½ by 10½ in.; pp. 64.

Sprockets.

Cullman Wheel Co., 1022 Greenwood Terrace, Chicago—Catalogue briefly describing sprockets for all purposes, together with tables giving dimensions and prices. Illustrated. 6 by 9 in.; pp. 48.

Stokers.

Under-Feed Stoker Co. of America, Marquette Bldg., Chicago—Second edition of pocket catalogue illustrating and describing the Jones under-feed mechanical stoker, together with several efficiency tables. 4¼ by 9 in.; pp. 24.

Traction Engines.

Abenaque Machine Works, Westminster Station, Vt.—Bulletin devoted to an illustrated description of gasoline traction engines. 6 by 9 in.; pp. 8.